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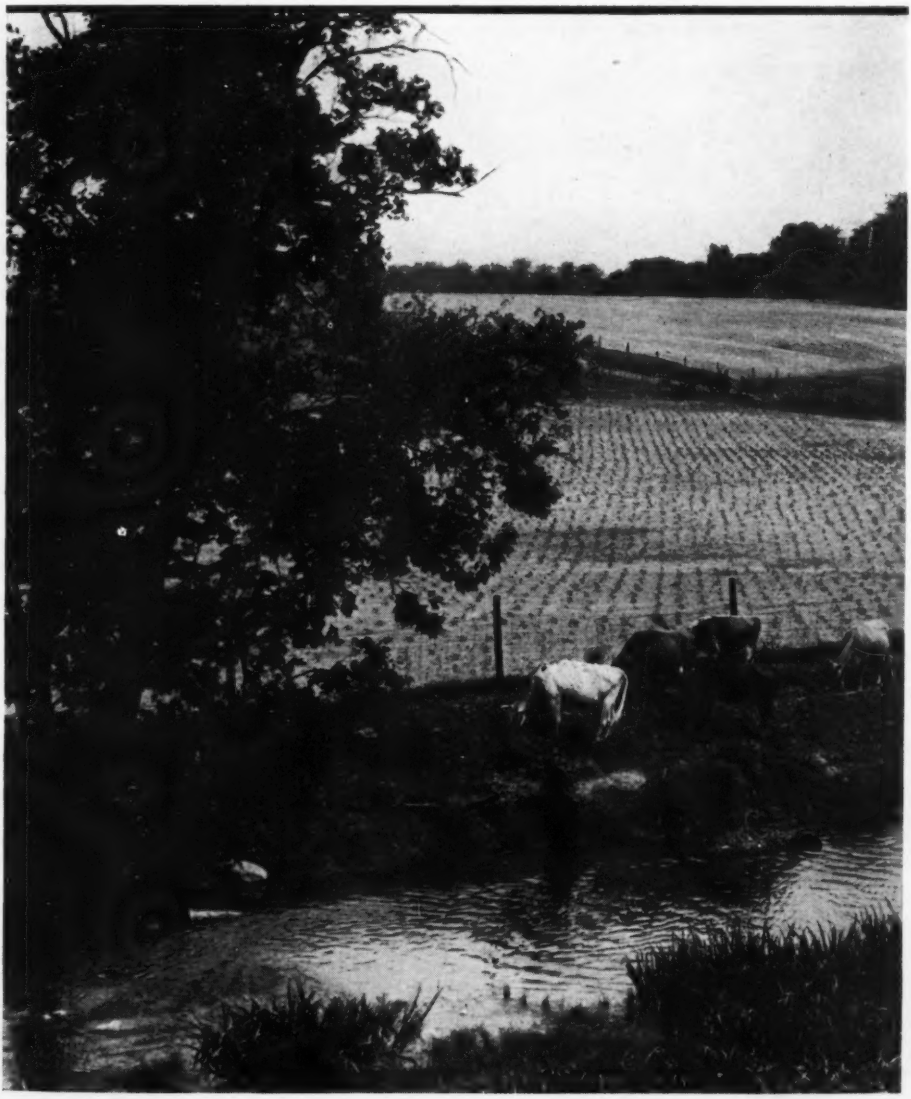

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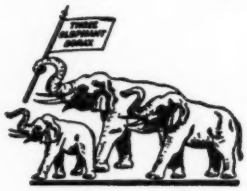


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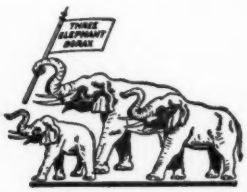


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# Better Crops with PLANT FOOD

The Whole Truth—Not Selected Truth

R. H. STINCHFIELD, *Editor*

*Editorial Office:* 1155 16th Street, N. W., Washington, D. C.

VOLUME XXVII NUMBER 5

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EVEN PIGS, AT TIMES, MAKE CUDDLY PETS.

Better Crops with PLANT FOOD

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VOL. XXVII WASHINGTON, D. C., MAY, 1943 No. 5

*All Out for . . . .*

# Victory Vitamins

Jeff McDermid

MARKET gardeners in my home state who coax commercial vegetables out of muck marshes are as jubilant as I have ever known them to be, with a hard season coming and tax money going. They are aglow with cheerful camaraderie. They beam as they sow beets and radiate while they radish the rows. Their good humor is no secret, but strange enough, it comes from war mania.

For peradventure, the mania of the day is for every amateur cultivationist to buy him a hoe and hie (heigh-ho) to the hinterlands. Arriving there, he will begin digging and delving for sustenance so that every town family shall build its own beans and construct its own cabbage with all the ardor of Adam and enterprise of Eve, before the snake snuck in and made a mess of things arboreal.

Whereat and whereby, and in consequence of, but minus high-sounding published resolutions, the aforesaid professional green-goods growers are as happy as though they had no beetles or blight to battle.

For they know with the same sense of fishermen that the amateur gardener will fall short of his aspirations with asparagus and his goal with gherkins. Finding himself lacking in prideful provender to tote kitchenward, he will pause at the nearest vegetable stand en route homeward and buy a succulent stock of vitamins.

Moreover, having blistered his palms and rheumatized his back sorting husky weeds from underprivileged vegetables, the amateur will for the first time in history appreciate the skill of the real garden farmers and open his wallet freely in token thereof. There has been no spring season since the w. k. depression when so much free advertising has been broadcast in behalf of them who cater to kale.

Ever since the point ration scheme got going in my community, the most popular stores have been the hardware

and seed emporiums. Take it from me and the clerks in those busy institutions, it isn't the Department of Agriculture that has stirred up this mess of ambition on the part of city slickers. Blame the OPA for any surplus of oleraceous and esculent herbs which manage to survive the weeds and white grubs.

BETS are being placed right now in some sections as to how long and how far the mania for muscular exercise with the hoe instead of the mashie will proceed when midsummer comes. Sundry small boys and members of Scout troops are even now laying shrewd plans for taking over the ambitious gardens of many who haunted the hardware stores in April.

They have certain simple contracts ready for the sunburnt and caved-in garden devotees to sign, which will state the wages per hour and the rate per mile for delivery of whatever provender can be ripened in those nifty war plots. Proceeds will go into the sinking fund of the troops, or into the urchins' own pockets to eke out his newspaper route income. I see no harm in such a system either, as the objective is to produce green victuals without bothering the usual sources of supply.

But isn't it a shame to think of all the cute and colorful costumes which women have designed for the express purpose of ravishing the rutabagas or having some stray newspaper photographer happen along conveniently before the gals have actually worked up an unbecoming lather? Society columns would be dull indeed this summer without feature layouts displaying beauteous damsels industriously pushing the wheel-hoe in tribute to him who pushes the enemy in far-off climes. Too bad about gardens being no good in the shade, and also too bad to boot that powder-puff rooms are not handy adjuncts of open spaces.

I have one nice dame friend who began her pre-season planning with acclaim, but who fizzled out at the first round by having a neighbor do the stooping at seeding time. Her dizzy spells will probably last longer than usual this summer, and most of the peas she harvests will be produced by proxy.

If my farm girl friends had the time to spare, they would easily get a new lease on life by watching the efforts of the urban sisters engaged for the first time in a serious attempt to get themselves a grubstake. Here and there, now and then, they would find some city woman with grit and gumption enough to work as hard as she plays outdoors.

City men are not much better either. The exceptions are those who have wrestled with quack and crab-grass trying to keep a wide lawn showy and glossy. They have the makings of a garden in mind and know a little about the hidden pains thereof. If they go very far into the country, however, they will look in vain for the hose reel and the convenient water tap, and maybe take lessons in praying for rain with their rural friend who rented them the land.

ONE of these gentry lasted just long enough to find a mess of writhing angleworms beneath his spade. He at once remembered that the open season for bass was due, and the garden knew him no more. Another earnest garden fiend from my ward got his stuff well up in the rows in time to make a pleasing dish for some pedigreed chicks. Thereat he decided to trade his chances with the cutworms for a few broilers, and abandoned the plot to the farmer in exchange for chicken rights.

One of my farmer friends adjacent to a suburban area complains that he has been pestered plenty this spring by folks dropping in with hand baskets and cardboard cartons wanting them filled with "well-rotted animal residues." He didn't know what to charge them for rich plant food sold in such driblets. Although the OPA has not set any ceiling price at retail for cow manure peddled to ambitious urban

plant coaxers, he did his best to be considerate without being a barnyard profiteer.

Speaking of fertilizer, this season has educated a lot of city folks on the cost of production. Most of them have an idea though that the only formula ever used is 3-8-7—and if their plots fail to make magnificent returns on the investment, they'll have it in for the guy who named that mixture "Victory."

But who am I to poke fun at other

amateurs? Instead, my task should be to write a brochure on the subject "Why I Garden and If So, When." My own plot would make an ideal laboratory for such a thesis. My wife wonders why I garden, and my neighbors wonder when.

Experiment stations produce most of the current bulletins conned by amateurs. My garden is an experiment station, or it is nothing—perhaps both!

In my philosophy I recognized five kinds of gardens, viz. and to wit: winter and summer; absentee or mental gardening; and the formal and informal. The winter and absentee systems require no tools, but for the other three I advise building a machine shed, with priority permits from the War Board.

In my winter gardening, I empty more cigarette packages than seed packets. My urge for winter gardening has the extra thrill that comes because my seed and nursery catalogs arrive on the rural delivery by the same red-faced carrier who brings my bills and the bulky South Dakota bibles full of teasing merchandise. He is the Santa Claus of my pipe-dreams, and the good government pays him to bring me solace amid the snows. He showers upon me the stimulus of Henderson and Ferry, and presents me with a picture gallery of wonderberries beyond compare.

He makes me forget the quack-grass roots of literal life while I revel in the land of lithographs. The main reason why I seldom over-indulge in spring bitters for a tonic is because those gorgeous catalogs in the dormant season have given me the needful bracer and made me see strange things without recourse to liquids. I do not worry if none of those dreams materialize, as few of them do when it gets hot around the collar. I have had my succulence and sustenance by the fireside, gazing in awe at the art of the printer.

Absentee gardening is painful. It arises partly from envy and partly from admiration, and always carries with it a deep sense of horticultural inferiority complex. After seeing a successful garden one may try to imitate it, but skill and experience are not secured over night. I cannot recommend absentee gardening, for it is like absentee landlordism—hard on the soil and tough on the soul. To envy your friend's onions is a greater sin than to grow them and have your own halitosis. Imitation gardening is only a hindrance to pioneer spirits moving in a wilderness of weeds toward the hopeful harvest of a meager hill of beans.

FORMAL gardens are to my way of thinking no more comfortable than formal clothes. As a rule, when the large formal gardens on large estates are in their highest degree of starchiness and primness, there is nobody left on the premises but the underlings. Maybe the owners of such places take their vacations to escape the graveyard feeling that such tortured geometric gardens give.

On the contrary, our own middle-class home gardens appease the palate, appeal to the perceptions, promote

(*Turn to page* 51)

# Malnutrition Symptoms and Plant Tissue Tests of Vegetable Crops

*By H. Hill*

Division of Horticulture, Central Experimental Farm, Ottawa, Canada

VEGETABLE crops require a high level of soil fertility to promote rapid and uninterrupted development. The light sandy loams on which a large proportion of our vegetable production is located are not naturally highly fertile, and the organic muck soils though high in nitrogen are low in minerals, particularly potash. Despite the recommendation and general use of fertilizer formulae such as 4-8-10, 2-12-10, and 2-8-16 at rates of 1,500 to 2,000 pounds per acre, malnutrition disorders of vegetables frequently occur.

The use of rapid chemical soil tests for estimating the fertility level of an unplanted soil has proven valuable in detecting extreme deficiencies, but the application of fertilizers to correct such recognized deficiencies has not always been successful, nor can such tests be used to follow the nutritional status of a crop at various stages of development.

Symptoms of malnutrition must be recognized in the incipient or initial stages if they are to be useful in establishing a remedy for the growing crop. They are perhaps more valuable in preventing trouble from occurring in subsequently planted crops.

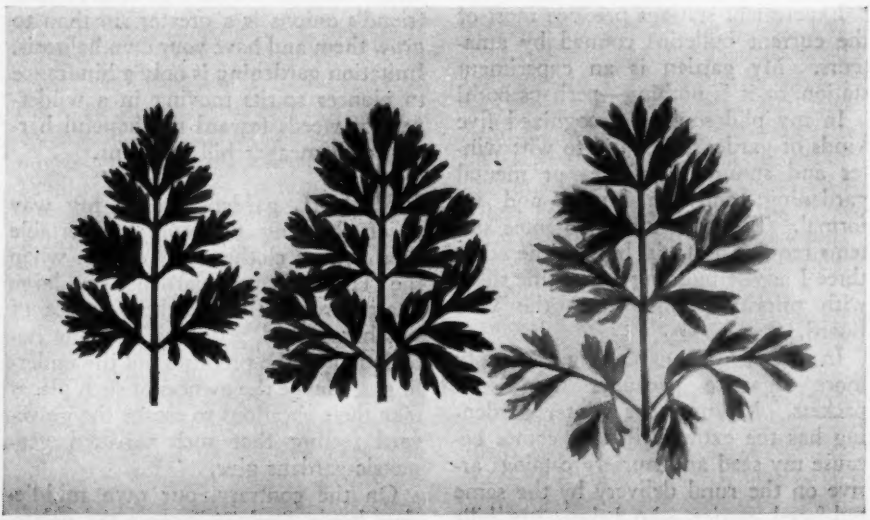

**Fig. 1. Carrot—Phosphorus deficiency. Progressive purpling of the leaves, followed by fading of the chlorophyll in the basal leaflets.**

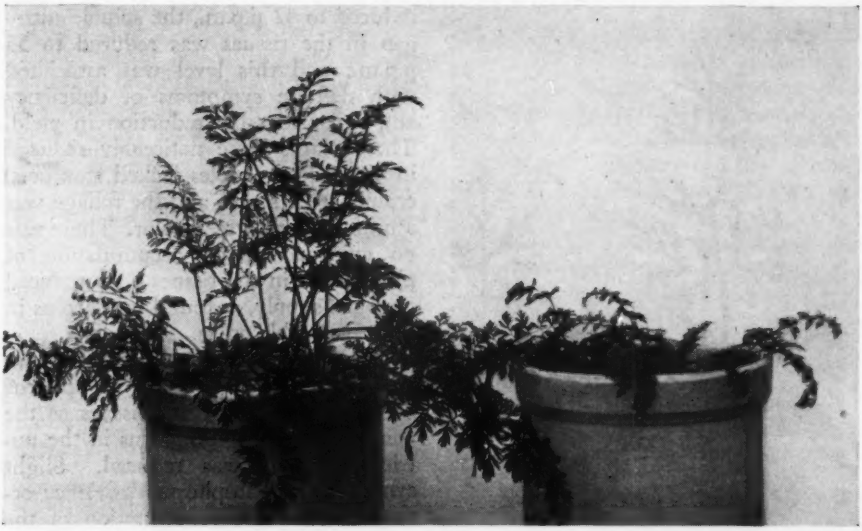

**Fig. 2. Left—Complete solution. Right—Deficient potassium. Note the marked dwarfing and decumbent habit of growth.**

Rapid chemical plant tissue tests provide a means of determining the active portion of the nutrient content of the plant during its development and consequently are not only useful in diagnosing definite deficiencies but in determining whether initial applications of fertilizer have accomplished their purpose.

The following notes are concerned with deficiency symptoms and plant tissue tests of carrots, garden peas, and

TABLE 1.—CARROTS—AVERAGE YIELD PER PLANT AND RESULTS OF PLANT TISSUE TESTS

| Treatment | Average weight in grams per plant | Expressed in p.p.m. in petiole tissue | | | |
|---|---|---|---|---|---|
| | | Sol. P | $K_2O$ | MgO | Sol. N |
| Nitrogen 336 p.p.m. | 79.6 | 250 | 7800 | 250 | 833 |
| " 168 " | 53.9 | 250 | 7216 | 125 | 521 |
| " 84 " | 81.0 | 187 | 7216 | 125 | 641 |
| " 42 " | 38.3 | 250 | 7800 | 125 | 55 |
| Phosphorus 51 p.p.m. | 79.6 | 250 | 7800 | 250 | 833 |
| " 25 " | 68.0 | 125 | 2954 | 125 | 781 |
| " 12 " | 52.0 | 22 | 3936 | 187 | 568 |
| No phosphorus | 10.6 | 15 | 3282 | 187 | 260 |
| Potassium 257 p.p.m. | 79.6 | 250 | 7800 | 250 | 833 |
| " 128 " | 56.7 | 187 | 5906 | 250 | 543 |
| " 64 " | 53.7 | 156 | 3936 | 437 | 500 |
| " 32 " | 28.1 | 156 | 3936 | 437 | 480 |
| No potassium | 11.2 | 250 | 656 | 250 | 125 |
| Magnesium 19 p.p.m. | 79.6 | 250 | 7800 | 250 | 833 |
| " 9 " | 83.5 | 187 | 5200 | 62 | 568 |
| " 5 " | 65.1 | 250 | 6500 | 62 | 694 |
| No magnesium | 65.3 | 250 | 7800 | 62 | 1041 |

Fig. 3. Potassium deficiency. Foliage dull dark green with tips scorched a tan to whitish-brown, scorching finally extending into the leaf.

beets grown in sand culture in the greenhouse. Preliminary feeding was made with a complete solution in order to get the plants well established.

Series of plants were grown with the following concentrations of nitrogen, phosphorus, potassium, and magnesium in the nutrient solutions: nitrogen—336 p.p.m., 168 p.p.m., 84 p.p.m., 42 p.p.m.; phosphorus—51 p.p.m., 25 p.p.m., 12 p.p.m., and no phosphorus; potassium—257 p.p.m., 128 p.p.m., 64 p.p.m., 32 p.p.m., and no potassium; magnesium—19 p.p.m., 9 p.p.m., 5 p.p.m., and no magnesium.

**Carrots**—The average yield in grams per plant is recorded in table 1. Plant tissue tests were made of the leaf petioles according to the method of Carolus; these are also recorded.

The reduction of nitrogen in the nutrient solution to 84 p.p.m. was reflected in a drop of soluble nitrogen in the tissue from approximately 800 to 600 parts per million. This concentration still provided for ample or luxury absorption by the plant as shown by growth and yield data. When the nitrogen concentration of the solution was reduced to 42 p.p.m., the soluble nitrogen in the tissues was reduced to 55 p.p.m., and this level was associated with definite symptoms of deficiency and a considerable reduction in yield. These plants were noticeably reduced in vigor, leaf petioles lacked stoutness, crowns were small, and the foliage was a uniform light green color. There was no evidence of an accumulation of phosphorus in the tissues with reduced nitrogen supply, as found by Carolus in other vegetable crops.

There was a consistent reduction in yield and in the soluble phosphorus determined in the plant tissues as the concentration of phosphorus in the nutrient solution was reduced. Slight symptoms of phosphorus deficiency occurred when the concentration of the solution was reduced to 25 p.p.m. and the level in the tissue was 125 p.p.m. Although the vigor was not greatly reduced, the foliage was generally dull dark green in color with one or two of the older leaves being tinged with a dull purple. Very marked deficiency symptoms developed when the concentration in the solution was reduced to 12 p.p.m., or when no phosphorus was supplied, and when the level in the tissues was 22 and 15 p.p.m., respectively. It is suggested that reduction in yield and symptoms of deficiency are likely to occur if the soluble phosphorus in the conducting tissue is not above 125 p.p.m. during the active growth period. Plants suffering from severe

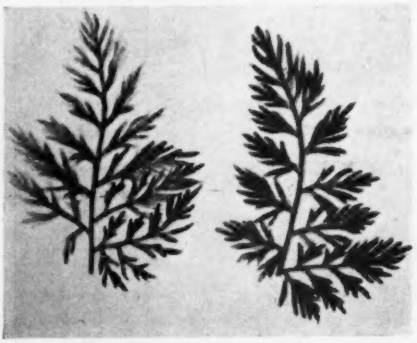

Fig. 4. Boron deficiency—Distinctive pink to reddish colouration of affected leaves.

deficiency were characterized by loss of vigor, slender petioles upright in habit, young developing leaves dull dark green and reduced in size, with older leaves and petioles a distinctive dull purplish color (fig. 1).

When no potassium was supplied in the nutrient solution, very marked symptoms of deficiency were noted. Plants were weak and very dwarfed in habit. The leaf petioles were slender and characteristically decumbent compared with the upright habit in other treatments, (fig. 2). At first, the foliage was dull dark green to bluish-green while the tips and serrations of the leaflets were scorched a tan to whitish-brown, (fig. 3). The scorching finally extended into the leaf, and dying of the leaf took place. The plant tissue contained 656 p.p.m. of potassium. Nutrient solutions containing 32 or 64 p.p.m. produced plants showing incipient potassium deficiency in reduced vigor, dwarfed habit of growth, dull dark green foliage, but absence of scorching. The plant tissue contained 3,900 p.p.m. of potassium. No significant symptoms were recorded when the solution contained 128 p.p.m. and the tissue 5,900 p.p.m. of potassium, but higher yield was obtained when the tissue analysis was 7,800 p.p.m. It will be noted that a decrease of potassium in the plant tissue is accompanied by an increase in magnesium except in the case of total omission of potassium feeding, in which case the deficiency was so severe that the plants were barely surviving.

The omission or reduction of magnesium in the nutrient solution only caused a slight reduction in yield, and no definite symptoms of deficiency were recorded although the magnesium in the tissue was reduced considerably. It would appear that the initial feedings of a complete solution maintained magnesium in the tissue at a sufficiently high level to prevent deficiency from occurring.

**Fig. 5. Peas—Right—Deficient phosphorus. Note widely spaced leaflets. Left—Deficient potassium.**

A group of plants was also grown with a nutrient solution lacking boron, causing marked and distinctive symptoms to develop. The foliage symptoms commenced as a yellowing around the margins of the leaflets. This yellowing was followed by a distinctive pinkish to reddish colouration extending back into the leaf, the affected tissue finally dying and turning brown, (fig. 4). The carrots were typically affected with wide, deep splits.

TABLE 2.—GARDEN PEAS—AVERAGE YIELD PER PLANT AND RESULTS OF PLANT TISSUE TESTS

| Treatment | Average weight of shelled peas in grams | Expressed in p.p.m. in plant tissue | | | |
|---|---|---|---|---|---|
| | | Sol. P | $K_2O$ | MgO | Sol. N |
| Nitrogen 336 p.p.m. | 25.0 | 500 | 9184 | 500 | 250 |
| " 168 " | 18.5 | 312 | 5252 | 625 | 116 |
| " 84 " | 22.2 | 250 | 5252 | 562 | 67 |
| " 42 " | 25.1 | 312 | 7872 | 375 | 77 |
| Phosphorus 51 p.p.m. | 25.0 | 500 | 9184 | 500 | 250 |
| " 25 " | 23.7 | 156 | 5252 | 312 | 231 |
| " 12 " | 12.0 | 46 | 7878 | 312 | 235 |
| No phosphorus | 2.0 | 15 | 2954 | 125 | 205 |
| Potassium 257 p.p.m. | 25.0 | 500 | 9184 | 500 | 250 |
| " 128 " | 24.7 | 624 | 4592 | 562 | 187 |
| " 64 " | 20.4 | 500 | 4592 | 375 | 266 |
| " 32 " | 13.3 | 500 | 3282 | 375 | 148 |
| No potassium | not developed | 875 | 2626 | 875 | 543 |
| Magnesium 19 p.p.m. | 25.0 | 500 | 9184 | 500 | 250 |
| " 9 " | 29.6 | 437 | 5252 | 47 | 271 |
| " 5 " | 25.1 | 466 | 5252 | 31 | 208 |
| No magnesium | 19.6 | 625 | 6565 | 31 | 357 |

**Garden Peas**—The average yield in weight of shelled peas in grams per plant is recorded in table 2, along with results from plant tissue tests which were made on the main stems at blooming time.

The reduction of nitrogen in the nutrient solution resulted in a marked reduction of soluble nitrogen in the conducting tissues of the plant. Since yields were not appreciably reduced nor were symptoms of nitrogen starvation evident, it is probable that at this stage of growth, about 70 p.p.m. in the tissue are satisfactory.

The reduction or omission of phosphorus in the nutrient solution resulted in a marked progressive decrease of this element in the plant tissues, associated with a progressive decline in yield. Reduction in vigor, the occurrence of deficiency symptoms, and marked reductions of yield were associated with levels in the plant tissue of 46 p.p.m. and under. Deficiency symptoms were characterized by spindly, weak stems, leaves widely spaced on the stems, and much reduced in size. Later the older basal leaves became yellow around the extreme margins; these areas then died and became yellowish-white in color, thin and papery in texture, (fig. 5).

The reduction or omission of potassium in the nutrient solution resulted in a corresponding reduction of this element in the plant tissue. Yields were materially reduced and deficiency symp-

(*Turn to page* 44)

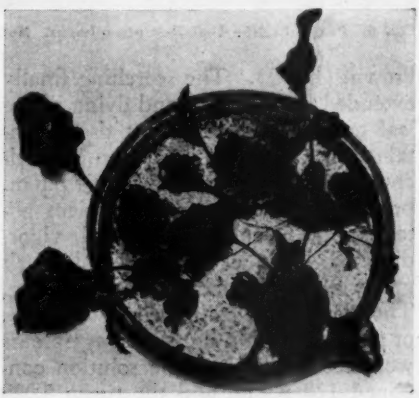

**Fig. 6. Beets—Deficient phosphorus.**

# *Value and Limitations of* Methods of Diagnosing Plant Nutrient Needs

*By George D. Scarseth*

Agricultural Experiment Station, Purdue University, Lafayette, Ind.

WITHIN the last 10 years agronomists and soil chemists have given much attention to the development of rapid chemical soil test methods as a means of determining fertilizer practices. Numerous comparisons have been made of the different methods used in the various states. One of the outstanding facts resulting from such studies is that no method has yet been devised that is infallible. This has brought on some criticism and doubt about the advisability of using such tests.

The criticism arises out of the tendency of the operator to expect too much of the tests. It is not reasonable to think that these soil tests, in all cases, should correlate closely with the crop responses obtained from the use of fertilizers nor with the true status of the soil fertility. The reason for this lack of correlation is obvious when some of the peculiarities involved are considered.

***Limitations of the Rapid Chemical Soil Test.*** Plant roots absorb elements out of the soil slowly but continuously for several months, while in soil tests the solvents are in contact with the soil materials for only a few minutes.

This would not matter so much in inorganic systems where chemical equilibrium is rapidly established, but in the dynamic, biotic soil complexes it is of utmost importance. Another consideration is that plant roots differ in their feeding properties; for example, sweet clover and alfalfa can obtain more phosphate in an alkaline soil than can corn or wheat. Soil tests, however, are usually designed for general crops and are not standardized for any particular crop or kind of soil. It is to be remembered that soil tests have extracting solvents differing variously in pH and composition from those of the different plant roots; and the presence or absence of free carbonates greatly affects the acidity of the solvent. Moreover, plants feed out of the subsoil as well as out of the top soil; thus, soil samples usually do not represent the entire root environment. The plants absorb elements out of the whole soil complex, part of which may be alkaline (subsoil) and part acid (surface soil).

From this, it seems clear that the chemical soil test methods can not be used as more than an aid in determining the phosphate and potash supply. For determining the need for nitrogen, the soil tests are almost useless. The soil tests for acidity are most useful and can be considered invaluable as a guide to liming. Nevertheless, if the user of such tests recognizes these values and limitations, the rapid chemical tests can be and are invaluable aids in diagnosing the fertility situation in the soil with respect to the static levels of fertility and soil acidity.

Presented before the Fertilizer Conference at Ohio State University Oct. 30, 1942. Journal Paper No. 56 of the Purdue University Agricultural Experiment Station, Lafayette, Indiana.

***Plant Tissue Tests as an Aid in Diagnosing Fertility Needs.*** Many fertilizer experiments have been handicapped or have failed to give true information because experimenters assumed that the growing crop was adequately supplied with a particular nutrient element. This assumption was strengthened if the nutrient had been added to the soil as a fertilizer in amounts assumed to be adequate. However, the mere addition of the nutrient to the soil is no assurance that it is effectively entering the plant. Since it is only the nutrient that gets into the plant that is effective in feeding the crop, it is most important to know whether or not the plant is absorbing this specific nutrient. The failure of the plant to obtain the nutrient may depend upon many factors such as: (a) too high placement of the fertilizer for the roots in drought periods, (b) movement of the nutrient to the surface out of reach of the roots, (c) leaching, (d) fixation, (e) poor root development or deficient aeration, and (f) toxic root zones.

Frequently fertilizer experiments conducted to determine the crop response to a particular nutrient element have resulted in no increase in yield even though it was reasonable to believe that the soil was deficient in this element. In such experiments, the effects of the other nutrient elements have presumably been eliminated by their addition as constants or by the thought that they were adequate in the soil. Since no response was obtained from the particular element being studied, the conclusion has unfortunately often been drawn that the element was not needed. It is in such instances that some information on the nutritional status inside of the growing plant becomes most helpful.

***Purdue Plant Tissue Test Method.*** It is possible to determine, with the Purdue plant tissue test method, the nutritional status of a crop with respect to nitrate, inorganic phosphate, and potassium at any stage of growth. This technique has certain practical advantages and has served as a valuable diagnostic aid in evaluating the various soil treatments in the current fertilizer experiments in Indiana. Modifications in experimental work to eliminate some fundamental faults are being made as a result of information obtained with this procedure. The details of making the tests and the chemical solutions used are described in Purdue Bulletin 204 by Thornton, Connor, and Fraser.

**Fig. 1. Mack Drake diagnosing the nutrient status of corn by testing the tissues. The box on the ground is the Purdue test kit. The box on the tripod is a convenient outdoor work table. The compartments are handy for carrying the clean and used vials.**

From an extensive experience with the Purdue tissue test as a diagnostic aid, the author has found that the value of this test depends upon the common sense of the operator in making the logical interpretation of the results. He is compelled to abandon preconceived notions and must accept the facts presented by unalterable chemical reactions.

***An Analogy to Describe the Tissue Tests.*** The use of an analogy may help to make clearer the concept the operator must have to interpret the results from the tissue tests.

If a machine in a factory is to operate at its full capacity, all the conveyors bringing in the raw materials must be running full. The supply of these materials in the stock-pile must be adequate to keep each conveyor filled. Whenever a particular conveyor starts to run partially empty, it means that the supply in the stock-pile of that material is low, and the production of the machine must slow down to the rate of the intake of the element present in the least amount. The slow-down in production is the first response to the scanty supply of any of the necessary raw materials, because the quality of the finished product must be upheld to a certain standard. However, if operations must proceed on a very deficient supply of a particular material, there is grave danger that the quality must also be sacrificed along with the reduced production.

A factory superintendent will keep an alert eye on the conveyors to see that they are always running full. He notes that when the rate of production slows down as a result of a scanty supply of material on one of the conveyors, the other raw materials tend to accumulate in unused forms on their conveyors in front of the machine. He is not fooled into thinking such a situation represents an over-supply of these materials in the stock-piles.

This analogy becomes a reality when certain words are substituted. The cells in the plant become the machine where the manufacturing takes place. The nitrates, phosphates, potassium, and other nutrient ions are the raw materials, and the conducting tissues (xylem tubes) become the conveyors.

In making a rapid chemical determination of the contents of the plant tissues with the Purdue plant tissue test method, the operator is, in fact, looking at the conveyors in the plant to observe if plenty of such essential nutrients as nitrates, inorganic phosphates, and potassium are entering the plant and passing on to the points needed. This test indicates the presence or absence of these nutrients in the conducting tissues of the plant in soluble, unassimilated form.

When the intent is to ascertain the first limiting nutrient growth factor, it seems important to differentiate between nutrients that have been assimilated, and the nutrients that are unassimilated and still in the role of a raw material.

The "assimilation" of potassium is not understood. A freshly cut plant that shows no potassium present by the tissue test method but contains potassium as shown by ash analysis may show a "high" test by the tissue test method after the plant is dried. Potassium will leach out of dried hay, but not out of the hay before it is dried. This indicates that the potassium is held by some form of adsorption in the living protoplasm.

It is for this reason the conveyor-tissue parts are cut instead of crushed or ground. The test does not show nutrients that have been assimilated into organic compounds. In this respect, the Purdue method differs markedly from tissue tests where the material is ground and emulsified, as in the Hestor method (Commercial Year Book 1941); or where analyses are made of the total contents of the nutrients in a part of the plant as in Thomas' and Mack foliar diagnosis method (Penn. Expt. Sta. Bul. 378); or where small amounts of ash are analyzed by the spectrographic method.

***Plant Tissue Tests Have Different Objectives.*** It should be recognized that the Hestor plant tissue test is a relatively rapid laboratory test and has an important advantage in being quantitative. In the foliar diagnosis method of Thomas or in the spectrographic method, a quantitative laboratory analysis is involved. These methods are relatively long but invaluable in those kinds of research

where precision is required. However, in the practical diagnosis of nutritional problems with growing crops, the semi-quantitative results obtained with the Purdue method are most helpful because of the rapidity and ease of making the tests. The large number of tests that can be made in a few minutes makes it an unpardonable laxity to guess at the nutritional status of the growing plant, when a large portion of the guess-work can be eliminated. If practical problems must rely on long precision methods for an answer, the common and natural procedure is to let the diagnosis pass with a guess and, more unfortunately, ignore the need for information on the nutritional status within the plant.

***Diagnostic Point of View is Necessary.*** A person confronted with the problem of a poorly growing plant has somewhat the same problem as a medical doctor in a clinic when confronted with a patient. The diagnostician of plant difficulties must consider the optimum requirements of the plant as to temperature, moisture, freedom from insects or diseases, and nutrient supply. He must have an appreciation of the genetic potentialities of the plant, and must know when the plant is performing at its optimum, with respect to all external factors. A large crop of good quality should serve as the ultimate objective at which to aim.

Whenever a crop falls short of being as good as the best, the question arises, —What is the factor or factors holding back performance? Here the diagnostic procedure or common sense approach causes the diagnostician to examine all possible causes of trouble. How acid is the soil? Is it too acid for the crop or for legume bacteria? Is the acidity great enough to cause toxic amounts of soluble aluminum? Is the aeration so poor that it causes an anaerobic decomposition and the formation of toxic ferrous iron, or hydrogen sulfide, and/or the loss of nitrogen by dinitrification? Has the soil a cropping history of depletion, or have manure, crop residues, or fertilizers been used? If so, to what extent and kinds? How much corn, wheat, potatoes, soybeans, cotton, sugarbeets, etc., did the soil produce in past years? Do these yields reflect a high or low state of fertility? What are the characteristics of the soil? Is it low in organic matter so that nitrogen may be one of the first limiting factors? Is it a dark colored or muck-like soil so that $K_2O$ may be the first limiting factor? The diagnostician may test the soil for so-called available nutrients. He recognizes the limitations of these tests, but they add information.

Then, if there is a crop growing, he looks for nutrient deficiency symptoms. These are another guide, but they are not always conclusive because nutrient situations may change within plants as they develop, or as the rainfall varies. He then goes a step further and analyzes the plants. A quantitative test of the tissues is desired in some instances, but in the practical diagnostic approach, the semi-quantitative test is adequate because the question is to find out if there is an abundance or absence of soluble nutrients present in the plant conveyors at the particular time of making the test.

The tissue test will indicate a nutrient deficiency before the leaves show the starvation symptoms.

Since the plant is a dynamic system growing out of the equally dynamic soil, where conditions of nutrition vary within the plant with the stage of growth, root development, and formation of the seed or fruiting body, and vary within the soil with moisture, fertilizer placement, aeration (oxidation and reduction), organic content (energy for micro-organisms), temperature, and other factors, it is easy to see that variations in the nutrition of a plant as it grows are to be expected. This complexity of conditions has discouraged some from attempting to make tissue tests. Nevertheless, if the nutritional status within the plant is determined frequently during its growing period,

**Fig. 2. On the left, the base of the corn tassel is being sliced for the phosphate test. On the right, the leaf tissues are being cut for the potash test. The midrib of the leaves can also be used for making the phosphate tests. All of the leaves on the plant should show high phosphate and potash as well as nitrates throughout the growing period in a plant adequately supplied with these nutrients.**

one gathers the information regarding the factors of nutrition which are limiting at any particular period.

It has been said, "Here is a field that shows low in nitrates in one plant, low in phosphate in another plant, and perhaps low in potash in still another; therefore, the tests are no good." In such a case the true situation is that the field is very deficient in all three nutrients, and the variations in tissue-test results are reflecting the true variation in the soil and in the plants. It must be realized that the tissue test indicates only what element is the first limiting nutrient growth factor at the time of the test.

A plant physiologist realizes that a plant is not uniform throughout its tissues in nitrates, phosphates, and potassium. Therefore, on what tissue should the test be made? A plant abundantly supplied with nutrients, so that more nutrients would not affect the plant growth, would show a "high" test in any of its tissues.

As the supply of nutrients falls off, the lower part of the plant will become deficient in phosphate and potassium before the growing tissues in the upper part of the plant are deficient. Such a plant may be producing a crop that is acceptable as to yields, but it is not going to yield as high as it would if the whole plant had a high test throughout the growing period in all its parts. This occurs without exception on fields of high-yielding corn.

As the supply of nitrates decreases, the upper part of the plants, where maximum utilization is in progress, will show a low test for nitrates first. Nitrates may show "high" in the base of the plant stalk after the upper plant part shows "low." Such a plant may be growing acceptably well and show no nitrogen-starvation symptoms, but may be slightly handicapped in its growth because of a slight shortage. If the base of the stalk shows no nitrates, the plant is starving seriously for nitrogen. The base of the stalk may show the presence of nitrates in the early morn-

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# Poultry Manure— Source of Nitrogen

*By G. T. Klein*

Extension Poultry Husbandman, State of Massachusetts, Amherst, Mass.

AS the chemicals which are the base of nitrogenous fertilizers take their place on the war front, there is increasing interest in poultry manure as an alternate fertilizer. But poultry manure is not a completely balanced fertilizer, and so it is important to use it in the way that yields greatest returns.

Poultry manure is produced in excess of home needs on many of our commercial poultry farms and in the fattening and killing plants. If a poultry raiser is operating a general farm, the best possible use that can be made of it is on the fields. Many of the commercial farms are, however, small in size and use cannot be made of all the manure that is produced.

There are many arrangements for disposing of manure. The price for the past 10 years has been just what one could get for it. Many sales have been to dairy and vegetable farms, but it has many other possibilities. A rather common practice has been to give the manure as the pay for cleaning the house and renewing the litter on the poultry house floor. It is a very fair proposition for both parties.

When the poultryman cleans the house and sells the manure for cash, it has been priced at $3 to $5 a cord, in most instances. A cord of manure is equivalent to about three tons, or 100 bushels. The moisture content of fresh manure will average about 75 per cent, although some samples will run 85 per cent. Rhode Island Red hens weighing 5.5 pounds will produce about 47 to 50 pounds a year. More than half of this will be collected as droppings under the roosts, and the remainder will be in the form of litter manure. The straight droppings weigh 60 to 70 pounds per bushel and the litter manure about 48 pounds or about two tons to the cord. The litter manure is considered to be worth about two-thirds as much as the straight droppings.

A common practice on commercial poultry farms in the Northeast is to use litter on the floor for an entire year without changing, starting with fresh material when the layers are housed in the fall. Fresh litter is added once or twice monthly until a layer of six inches or more is built up by early winter. It

**This house has droppings pits which are cleaned four times yearly. A litter carrier dumps them on a platform at the end of the building or in a manure spreader. Potash and phosphorus are mixed with the manure before it is used.**

is stirred with a fork and this together with the scratching of the hens usually keeps it reasonably dry. The following summer when the house is cleaned for the new crop of pullets, the litter contains a large percentage of manure. This is valuable as a fertilizer.

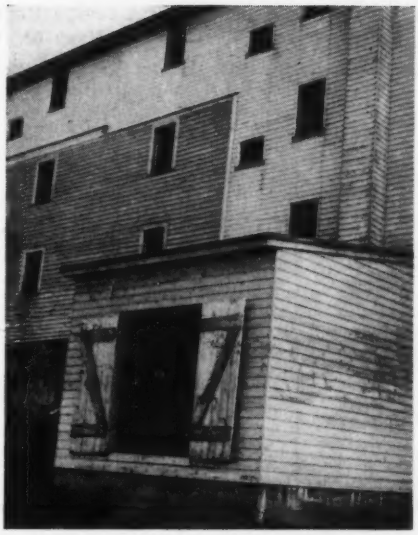
This method of litter management is practiced because it is the only way of keeping the floor dry, especially in areas where the humidity is high and the temperatures are low. Shavings are quite often used for litter because of their availability and the scarcity of other materials. It is also a very common practice to use droppings pits for collecting the roost manure. These pits are cleaned only three or four times a year and, of course, yield straight manure.

On the basis of a ton, the roost manure contains about 20 pounds of nitrogen, 16 pounds of phosphorus ($P_2O_5$), and 8 pounds of potash ($K_2O$). The average plant-food content is one per cent nitrogen, .8 per cent $P_2O_5$, and .4 per cent $K_2O$. The analysis will vary considerably with the ration of the flock.

Poultry manure, it is quite evident, is lacking in both potash and phosphorus, but fortunately these plant foods are not rationed. The use of 0-20-20 or 0-14-14 fertilizer to balance it has been recommended and extensively used. Experiments with vegetables, fruits, and to some extent with lawns and field crops have been under way at Massachusetts State College.

There has been considerable fear among gardeners and horticulturists that poultry manure, if used liberally, would cause burning. There has also been talk that shavings used for a litter are undesirable to have on the land and that they cause an acid condition. Tests were set up in 1942 to determine the yield and burning effect on tomatoes, sweet corn, cabbage, and carrots. The following material is taken from the report.

"There were six treatments replicated two times and each treatment was applied broadcast to the plots. The following treatments were used: one ton of 5-8-7 commercial fertilizer at the rate of one ton per acre; 5 tons of poultry manure per acre; 10 tons of poultry manure per acre; 5 tons of poultry manure plus 1,000 lbs. of 0-20-20; 5 tons of poultry manure plus 500 lbs. of 5-8-7 fertilizer; and 16 tons of horse manure.



**Here the droppings are scraped from the platform twice a week. The chute empties into the pit where droppings are stored until they are sold. The closed pit is preferable because it prevents loss of plant food from rain.**

"The soil of the plots is a sandy loam and is naturally fertile. Rainfall occurred in sufficient quantity at frequent intervals, so that growing conditions were ideal."

The yields obtained from the respective plots are shown in the table.

"It is to be noted that greatest yields were obtained with tomatoes when five tons of poultry manure were supplemented with 500 pounds of 5-8-7 fertilizer. The greatest yields of sweet corn were obtained when five tons of poultry manure were supplemented with 1,000 pounds of 0-20-20 fertilizer. This treatment also gave the greatest yields of carrots. The plots receiving 5-8-7 fertilizer at the rate of one ton per acre gave the greatest yields of cabbage, although the yields between these plots

COMPARATIVE YIELDS FROM VARIOUS FERTILIZERS, INCLUDING POULTRY MANURE, AS USED ON VEGETABLES

| Crop Lbs. | Plot | 1 ton 5–8–7 | 5 tons poultry manure | 10 tons poultry manure | 5 tons poultry manure + 1,000 lbs. 0–20–20 | 5 tons poultry manure + 500 lbs. 5–8–7 | 16 tons horse manure |
|---|---|---|---|---|---|---|---|
| Tomatoes | 1 | 162 | 141 | 161 | 132 | 159 | 110 |
| | 2 | 167 | 202 | 166 | 104 | 196 | 136 |
| | Av. | 164.5 | 171.5 | 163.5 | 118 | 177.5 | 123 |
| Sweet Corn | 1 | 120 | 93 | 131 | 129 | 99 | 119 |
| | 2 | 100 | 137 | 98 | 141 | 122 | 125 |
| | Av. | 110.0 | 115.0 | 114.5 | 135.0 | 110.5 | 122.0 |
| Cabbage | 1 | 284 | 251 | 300 | 277 | 268 | 220 |
| | 2 | 320 | 294 | 291 | 271 | 283 | 261 |
| | Av. | 302 | 272.5 | 295.5 | 274.0 | 275.5 | 240.5 |
| Carrots | 1 | 194 | 198 | 191 | 200 | 197 | 199 |
| | 2 | 241 | 221 | 223 | 238 | 231 | 223 |
| | Av. | 217.5 | 209.5 | 207 | 219 | 214 | 211 |

and those receiving 10 tons of poultry manure are probably not significant. Two plots planted to tomatoes in the greenhouse which received poultry manure at the rate of 20 tons per acre broadcast have not displayed the characteristic burning described by those who discount the use of poultry manure for growing vegetables."

From a one-year test of this nature, definite conclusions cannot be drawn. However, under the conditions which prevailed, there are indications that poultry manure and the fertilizer combinations cause little injury to these crops and when properly used give satisfactory yields.

The need for potash and phosphorus is clearly seen as one visits dozens of poultry farms, as I do yearly. On many of these farms manure is used very liberally and without other plant foods. It takes no expert agronomist to tell that something is lacking. It is particularly noticeable in the growth of clovers and to some extent with sweet corn, extensively used as a supplemental cash crop on many poultry farms. Probably a good combination for most crops would be 500 pounds of 0-14-14 to the acre, plus a fairly liberal application of manure.

Poultry manure plus the high phosphorus and potash fertilizers will be especially valuable for Victory gardens this year. Specialists in vegetable gardening recommend four to six cords of poultry manure to the acre, plus an application of anywhere from 600 to 1,200 pounds of 0-14-14. Translated into small terms, this would mean one bushel of manure to 100 square feet would give an application of 4⅓ cords to the acre, and 2.3 pounds or 4½ cups of inorganic material to 100 square feet will give a 1,000-pound per acre application.

Shavings, which have been mentioned as a commonly used floor litter, have not caused damage to crops as has been held by some gardeners. More rapid decomposition will result if the floor litter is plowed under rather than used as a top-dressing.

The combination of poultry manure and inorganic fertilizer is a good one, agronomists believe, for it puts the plant food very readily available and that more slowly available into the soil..

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# The Waverly Growers Cooperate on Citrus

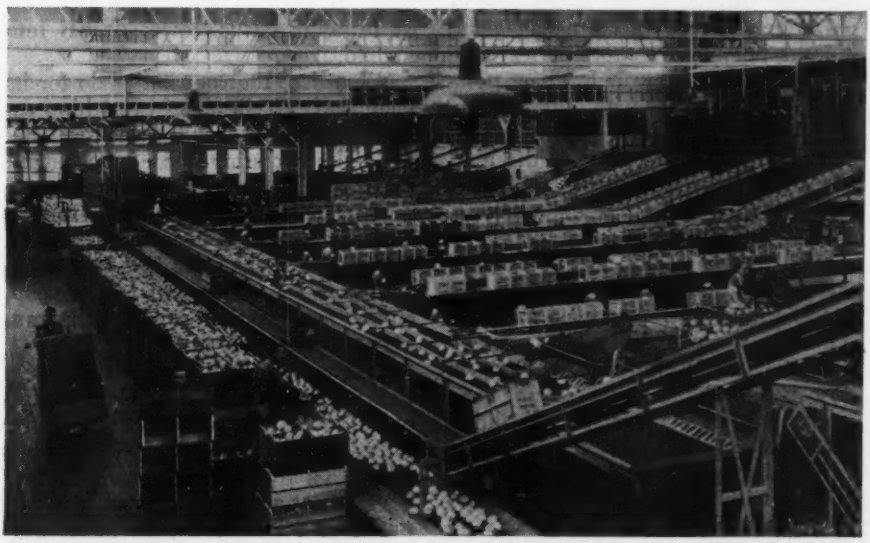
*By Jack Wooten*

Assistant Director of Information, Farm Credit Administration, Columbia, S. C.

LOCATED about midway between the famous Bok Tower and Cypress Gardens is Florida's Waverly Growers Cooperative. Now this is more than a name. It is an institution. It dates back to 1914 when a small group of men got together and created an organization of fruit growers to operate their own packing plant.

The association's first packing house was a mule barn, but that stable was not to remain as the habitat of the cooperative growers. By 1920 the Waverly citrus folks had moved into a new brick packing house—much larger than the former plant and with the most up-to-date machinery.

Time passed—not too much time, at that. Within eight years the cooperative had doubled in size and an addition had to be made to the packing house of 1920. Two years later—1930 to be exact—a large cooperative cannery was started in Lake Wales, where the Waverly group found an outlet in cans for skin-blemished fruit that was ordinarily wasted. This brought additional income and gave the growers an added incentive to stick together, verifying the slogan that in cooperative effort



**A view of Waverly Growers Cooperative packing house, showing grapefruit in field crates being conveyed to the washing machine and distributed to the packers. In the upper left center field of the photograph is a small office on the mezzanine floor, where electric counting machines make accurate record of every fruit as it drops into the packing bin. As it drops through, the fruit makes an electrical contact and at the end of each run, an accurate record is had of each individual fruit of each size and grade.**

**Interior of packing plant, showing girls wrapping and packing grapefruit. Notice the grapefruit traveling along the sizer rollers at the left of the picture and dropping into bins containing fruit of the same size.**

there is strength and in utilizing every bit of their citrus products there is profit!

Meanwhile the organization came to a realization that if it was to give its members the advantages of low cost of operation and really good management, it must become a competent servicing cooperative. There were fertilizer problems, insects to deal with, adequate refrigeration—these and many other things. An improvement of the market situation was needed. Shipping facilities should have more attention. The groves needed to be regularly inspected and carefully attended. And then, above almost everything else, cooperation among the grower members should be stimulated.

In 1935 the Waverly Citrus Growers Association changed its set-up to a stock form of cooperative. It didn't take in every Tom, Dick, and Harry as members. Those who became affiliated with the organization had to have groves worth taking care of, and had to have the spirit of wholehearted cooperation inculcated in them.

At the present time, there is a long waiting list of applicants. The citrus cooperative absolutely refuses to bite off more than it can chew. It has a system based on good management and good judgment. And it does a thorough job at the least possible cost to its members. It couldn't accomplish this aim by bringing citrus-grower drones into its fold.

What does the cooperative do for its members? Well, about everything except spend the money it earns for them.

Besides operating one of the biggest plants in the State, it supports its own sales organization, has a plant for the manufacture of fertilizer, makes its own insecticides, owns stock in a crate mill, and is still a major part of the cooperative organization running the cannery and feed mill at Lake Wales.

This year at the Lake Wales cannery, known as Florida Citrus Canners Cooperative, a large plant has been installed for the concentrating of orange juice. This plant was installed under government auspices, and its entire output is used by the United States government in sending juice to troops abroad and for lend-lease to allied nations.

The juice from two boxes of oranges

—approximately 10 gallons of juice—is concentrated or dehydrated under vacuum and placed as a thick syrup in a one-gallon can. In being prepared for use, this can is opened and the syrup is stirred into eight gallons of water, making nine gallons of rich, palatable orange juice which has retained flavor, vitamin, and mineral content with full food and health value.

The plant is now running 24 hours a day, 7 days a week, and is using from 12,000 to 15,000 boxes of fresh oranges every 24 hours. This is a real contribution to the war effort, inasmuch as it not only conserves valuable tin, but permits the transportation of high quality orange juice overseas with a great reduction in cargo space.

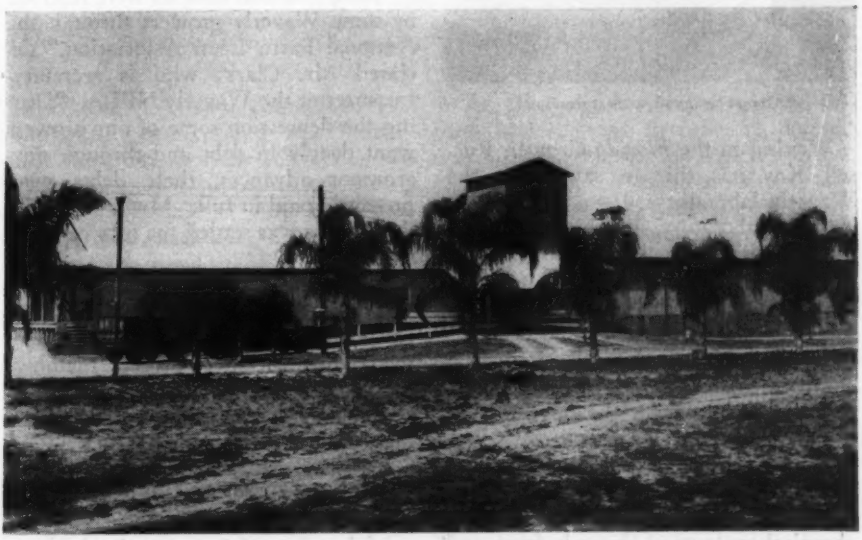
Servicing of the groves is most important. When a member engages Waverly Growers Cooperative to handle his business, he places his holdings completely in the hands of the management. The soil experts check the groves, make fertilizer recommendations, and endeavor to see that the members get the maximum benefits from their investment.

The production manager supervises the various steps in producing a good crop as quickly and cheaply as possible. Every detail is handled according to schedules adopted after a study is made of the particular grove and its peculiarities.

The groves are fertilized three times every year. Potash is one of the very important ingredients used in the mixture. The average grove requires the following fertilizer treatment:

One application in May or June, using a 1-1-2 ratio of nitrogen, phosphorus, and potash plus the minor elements including manganese, copper, and magnesium; second application in October or November, with the same ratio as used in May; and the third application in January or February, which is usually a top-dresser or straight nitrogen material.

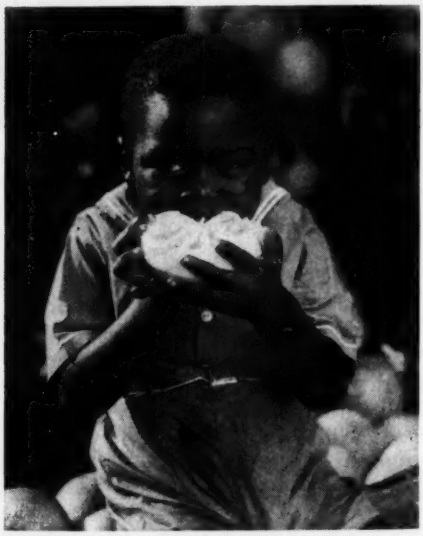
"Faced with the problem of producing quality fruit at a low price," John D. Clark, president of the Waverly Growers, declared, "We found that around 70% of the production cost came from fertilizer. So, we decided to build our own fertilizer plant. We have found that this plan, together with the program of making our own spray mixtures, has not only cut down



**In order to cut down costs for servicing their groves, the Waverly group built this modern fertilizer plant.**

the cost of servicing our groves, but has improved the quality and increased the quantity of our fruit!"

When the Waverly Growers established their own fertilizer-mixing plant, they employed a capable soil chemist to assist in determining just what formulæ were best suited to their needs. As a starter, they installed a modern chemical laboratory and made soil surveys of the groves of the cooperative members. Then they applied the kinds of fertilizers necessary to make the groves profitable.



**"Almost as good as watermelon!"**

Writing in the *Florida Grower,* Russell Kay has this to say about the Waverly laboratory:

"The laboratory, in charge of Professor J. B. Berry, has disclosed some remarkable facts with relation to what may be accomplished through the intelligent and scientific feeding of citrus trees to develop fruit high in mineral content. Not content to simply devise fertilizer formulæ for the development of healthy, heavy-bearing trees, Professor Berry, long a student of mineralization in foods, undertook the problem of actually increasing the essential chemical contents of Waverly fruit, and for many years has conducted experiments along this line. These experiments have led to the successful impregnation of soils so that the fruit itself contains essential minerals such as potassium, calcium, magnesium, iron, iodine, and other minerals in notably increased quantities."

The Waverly group has one unique distinction: Not a single member has ever gone into bankruptcy. That record is quite outstanding when you consider the fact that since its organization there have been a few "lean years" when oranges, grapefruit, and tangerines were not selling at a good profit.

And speaking of unique and outstanding accomplishments, there is one thing the Waverly citrus growers group can boast—it operates its own National Farm Loan Association, under the name of Waverly National Farm Loan Association. It was granted the privilege to operate individually by the Federal Land Bank when a consolidation of National Farm Loan Associations took place some years ago in Polk County. This was due in part to its excellent record in handling loans—because it saw to it that interest and principal payments were made on time and that all obligations were met.

"Real, practical benefits were received by some Waverly growers through the National Farm Loan Association," declared Mr. Clark, who is secretary-treasurer of the Waverly NFLA. "During the depression some of our growers went deeply in debt and through government advances, these debts were promptly paid in full. Much of this indebtedness was settled for fifty cents on the dollar."

In conclusion, President Clark stated, "Through the cooperation of the Federal Land Bank and the helpfulness of the Bank officials, Waverly members who took advantage of the money are now on a sound financial basis and making money."

It took a little prodding but Mr. Clark finally gave his ideas as to why the Waverly cooperative has been successful as a servicing organization.

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**Fig. 1. Good stand and yield of lespedeza are assured on soil well supplied with calcium, phosphorus, and potash.**

# Can Legumes Be Over-Emphasized?

*By Frank Moser*

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THE slogan, "Grow Your Own Nitrogen," is receiving much emphasis these days but the conversion of the legume into a supplemental nitrogen factory is not as simple as the phrase would indicate. Considerable time and proper soil management practices are necessary before the symbiotic production of nitrogen is assured. Nevertheless, the farmers who have judiciously followed the recommended conservation practices during the past decade are now in a most favorable position to utilize the inherent soil fertility and contribute very markedly to the "Food for Victory" program.

Leguminous plants when properly inoculated and returned to the soil in form of green manures add from 30 to 60 lbs. of available nitrogen per ton of plant material, but in order to obtain maximum symbiosis, the legumes must have access to an adequate supply of nutrients especially calcium, phosphorus, and potassium. Fertility requirements of the legume cannot be over-emphasized in the South, as in our haste to advocate supplemental sources of nitrogen we may fail to realize that all legumes are heavy feeders, and the amount of nutrients removed from the soil by these crops may even be greater than those absorbed by the cotton crop. For a 3-ton yield, crimson clover and lespedeza require approximately 100 lbs. of calcium, 25 lbs. of phosphorus, and 70 lbs. of potassium. Thus, unless these leguminous cover crops are well sup-

TABLE 1.—THE EFFECT OF VARIED pH VALUES ON REPLACEABLE CALCIUM, ACID-SOLUBLE PHOSPHORUS, AVAILABLE POTASSIUM, AND GROWTH OF CRIMSON CLOVER

| Pot No. | pH Value | Replaceable Calcium | Acid-Soluble Phosphorus | Replaceable Potassium | Yields |
|---|---|---|---|---|---|
| | | Lbs./Acre | Lbs./Acre | Lbs./Acre | Grams/Pot |
| 1 | 4.0–4.5 | 850 | 20 | 140 | 26.6 |
| 2 | | 870 | 40 | 148 | 29.5 |
| 3 | 5.0–5.5 | 1000 | 30 | 120 | 34.3 |
| 4 | | 1056 | 60 | 134 | 40.4 |
| 5 | 6.0–6.5 | 1750 | 35 | 100 | 42.3 |
| 6 | | 1792 | 70 | 120 | 53.0 |
| 7 | 7.0–above | 1900 | 40 | 121 | 36.9 |
| 8 | | 2000 | 80 | 127 | 41.5 |

plied with an adequate reserve of soil nutrients, very little benefit will be derived from their growth.

Recent experiments with these two crops emphasize the importance of the nutrient needs of legumes and show that high yields were obtained only for soils either well supplied or fertilized with calcium, phosphorus, and potassium compounds. Data secured by the South Carolina Experiment Station show that the maximum yield of 4,192 lbs. per acre of oven-dry crimson clover hay was produced on the plats receiving 2,000 lbs. of dolomitic limestone, 600 lbs. of superphosphate, and 100 lbs. of muriate of potash, while the average yield from the no-fertilizer plat was 2,150 lbs. per acre. In this experiment, potash was applied at a uniform rate of 100 lbs. per acre, which should have been adequate for normal conditions, but apparently this amount was not quite sufficient for soils having pH values above 7.0. As in case of the 4,000 lbs. limestone treatment, the pH approached 7.5 and caused a noticeable potash deficiency to appear on the crimson clover growing on this plat. The yield was considerably lower as compared with the optimum calcium treatment, 2,000 lbs. per acre. These observations indicate that where calcium is applied for stimulating growth of legumes, proper attention must also be given to the fertilizer application as adequate reserves of both phosphorus and potash are required for the successful production of this crop.

Supplemental greenhouse studies were conducted on these soils and the results are presented in Table 1. These substantiate the field data and further show that the pH treatments only slightly affected the available potassium content of the soil. In view of the fact that the potash application was constant for all plats, not much difference could be expected. Changing the pH caused a slight fluctuation in the potassium content of the soil from 140 lbs. per acre at pH 4.0 to 121 lbs. at the most alkaline range, pH 7.5. The lime treatments were effective for increasing replaceable calcium and acid-soluble phosphorus and for increasing the yield from 26.6 grams per pot to 42.5 grams, where the replaceable calcium content was raised from 850 lbs. per acre to 1,750 lbs. At higher fertility levels, induced by fertilization with superphosphate and muriate of potash, the available phosphates at each pH or replaceable calcium level were doubled;

whereas, all yields were larger giving a maximum of 53 grams per pot where 1,790 lbs. of replaceable calcium, 70 lbs. of acid-soluble phosphorus, and 127 lbs. of potassium were present in the soil. This would indicate that calcium increases the growth of legume crops, provided adequate reserves of phosphorus and potash are present in the soil, and must be supplied to southern soil to assure maximum production.

Aside from the increased nitrogen supply, the beneficial effect of growing legumes is especially noteworthy for soil conservation. Winter cover crops such as vetch, crimson clover, and Austrian winter peas are valuable for restricting erosion and leaching of soluble nutrients during the open winter months, while the summer cover crops, such as crotalaria and lespedeza, must be allowed to form a natural protective mulch in order to prevent erosion during the winter season. This latter practice is suitable for Southern conditions and is further emphasized by the data from the Tigerville, S. C., runoff experiment. Comparisons between the natural lespedeza residue treatment and the continuous cotton plat show that the natural mulch was very effective in controlling runoff, losing only 0.05% of the total rainfall occurring from November to March; whereas, the continuous cotton gave 18.2 runoff. While the corresponding erosion loss was nil with lespedeza, one ton was lost under cotton. Similar retardation in runoff and erosion occurred at Clemson, S. C., where green leguminous plant material was applied either as a surface mulch, or incorporated with the soil. These data show that the manner in which the organic materials are applied makes an enormous difference in its effectiveness. The results of the Clemson experiment show that during the 1940 season the runoff from the fallow plat (no organic addition) was 51.0%, whereas the incorporated treatment and surface mulch lost 40.0% and 4.5% respectively. Thus, these data suggest that leguminous additions to soil as mulches are extremely valuable in soil conservation and also improve the physical properties of soil, which are so closely associated with erosion.

Organic matter content of soils is almost synonymous with soil productivity and, therefore, any farm management practice which adds to the store of organic matter will greatly enhance crop

**Fig. 2. One sure way of adding nitrogen to soil is by plowing under the entire crop of crimson clover properly.**

TABLE 2.—YIELDS OF SORGHUM, ORGANIC MATTER CONTENT, AND AVAILABLE NUTRIENTS IN CECIL SANDY LOAM SOIL AS INFLUENCED BY DIFFERENT METHODS OF SUPPLYING LEGUMINOUS PLANT MATERIALS

| Treatment | Sorghum yields grams per pot | Organic matter content % | Available soil nutrients determined by laboratory methods | | | | |
|---|---|---|---|---|---|---|---|
| | | | Nitrate-nitrogen after the addition of plant material | | | Phosphorus p.p.m. | Potassium p.p.m. |
| | | | Outset | 60 days | 120 days | | |
| Check (No plant material applied) | 2.3 | 1.75 | 7 | 16 | 41 | 16 | 54 |
| 4 Tons crimson clover (incorporated with the soil) | 4.5 | 2.52 | 8 | 16 | 82 | 27 | 145 |
| 4 Tons crimson clover (applied as surface mulch) | 4.3 | 2.54 | 12 | 18 | 79 | 26 | 142 |
| Lespedeza (residues accumulated to form natural mulch) | 4.5 | 3.74 | 5 | 10 | 10 | 30 | 136 |

yields. A recent survey of Piedmont Plateau soils in South Carolina shows that the average soil is low in organic matter content and is usually less than 1%, while the use of lespedeza, vetch, and crimson clover in strip cropping and regular rotation systems has increased the amount to 1.68%, 1.47%, and 1.69%, respectively. This study also showed that soil containing more than 2.5% was obtained only on fields where lespedeza had been grown continuously and the entire plants returned as residues. Table 2 cites further information on various methods of supplying leguminous plant material to soil. All methods of application appeared to be about equally effective for increasing yields of sorghum, giving 2.3 grams per pot where no organic material was applied, while 4.5 grams per pot were obtained for the mulch and incorporated treatments.

The organic matter content in case of crimson clover was almost identical for the mulch and incorporated treatments, being 2.54% and 2.52%, whereas the accumulated lespedeza residue increased from 1.75% to 3.74%. The greater effectiveness of the latter treatment was undoubtedly due to greater quantities of plant material added.

The chemical composition of surface soil gave very interesting comparisons. In the case of nitrate-nitrogen the accumulation of nitrate from the crimson clover treatment was in accordance with commonly accepted theory on carbon-nitrogen ratios of decomposing organic material and developed 82 and 79 p.p.m. after 120 days in contrast to 41 p.p.m. found in check soil. The lespedeza accumulated mulch was decidedly lower than the check soil during the course of the experiment and remained between 5 and 10 p.p.m., but after the residues were plowed under and such materials incorporated, the nitrate formation occurred in orthodox fashion and in 120 days developed 61 p.p.m.

The effect of organic matter on acid-soluble phosphorus and replaceable potassium was quite striking. In the case of phosphorus, more acid-soluble phosphates were found on plats receiv-

(*Turn to page* 47)

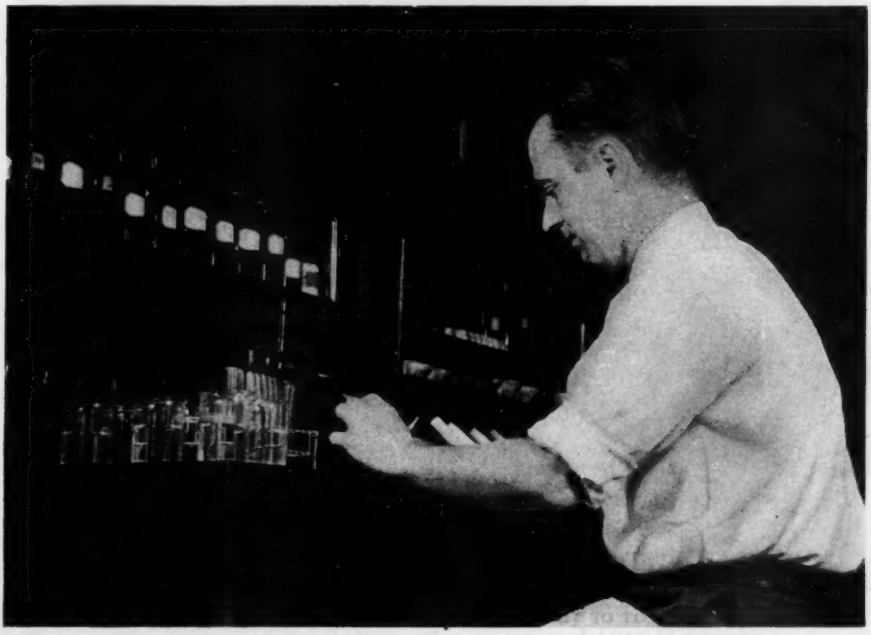
# PICTORIAL

THERE ARE A MIGHTY LOT OF THINGS FOR A YOUNG FELLER TO THINK ABOUT THESE DAYS.

*Scenes from the American Potash Institute's new motion*

**Above: Long years of a one-crop farming system resulted in the depletion of soils once fertile, and the abandonment of homes.**

**Below: With modern agricultural research came quick methods of testing soils for determining plant-food needs of various crops.**



*picture, "Save That Soil," taken in the South.*

**Above: Machinery to replace tedious and slow one-mule operations has made possible the rebuilding of millions of devastated acres.**

**Below: Progress, particularly in the growing of legumes, has led to diversification and the production of high-quality livestock.**

**Above: With current prices, every one is worth getting these days.**

**Below: Much softer than the ground if you can stay put.**

# The Editors Talk

## Save That Soil

The American Potash Institute is announcing the release of a new, color, sound motion picture entitled "Save That Soil." This film was taken during 1942 in the Southern States, namely, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. It depicts the plantation of the early South with its fine homes and fertile soil, the one-crop system of farming and subsequent depletion of the soil, and the final result—the abandonment of homes and land.

It shows the way this condition is being corrected by soil testing, tissue testing, and modern methods of soil management. The use of legumes in Southern agriculture is stressed. Scenes of such legumes as kudzu, blue lupine, crotalaria, Austrian winter peas, vetch, lespedeza sericea, crimson clover, lespedeza, alfalfa, hop clover, white Dutch clover, velvet beans, cow peas, peanuts, and soybeans are vividly portrayed on the screen. It is shown that the use of these legumes and good methods of soil management will make possible the growing of good crops and the economical production of high quality livestock—which in turn will provide happy homes, modern conveniences, and incomes for churches, schools, and community life.

The Institute expresses its deepest appreciation for the helpful cooperation in the production of this film extended by the Agricultural Experiment Stations in the Southern States. It also is indebted to the Soil Conservation Service, the U. S. Forest Service, the U. S. Department of Agriculture, the Agricultural Extension Service, teachers of vocational agriculture, and members of other advisory forces who so willingly gave their time, effort, and material in the preparation of this picture. Without their aid, "Save That Soil" never could have been made.

Copies of the film are ready for loan to groups noted on page 56 of this magazine, where other Institute films also are listed.

## Fertility Bonds

There isn't much interest in any kind of investment bonds these days except war bonds, which is as it should be. But now comes a suggestion for a "sort of" subclassification of this interest, namely, the earmarking of war-bond investment for specific purposes when cashing time comes around.

From William L. Baynes, director of the farm program for the war savings staff of Indiana comes the statement, "If every farmer will invest at least 60 cents per crop acre in bonds that he will earmark for the purchase of phosphate and potash,

it will insure him the ready cash to restore these plant foods after the war. The 60 cents per acre bond investment should be only a part of the farmer's total war bond investment, but bonds to that amount should be earmarked for the specific purpose of soil restoration."

Mr. Baynes arrived at his figure of 60 cents by estimating that approximately 57,000,000 lbs. of phosphoric acid ($P_2O_5$) and 44,500,000 lbs. of potash ($K_2O$) will be removed from Indiana farms through sale of products if goals are reached. This is the equivalent of 267,500 tons of 0-12-10 which at $34 per ton would cost $9,095,000, an amount representing the State's cropland acreage at 60 cents per acre.

The loss of this plant food through the sale of agricultural products does not include all of the losses that will occur. Authorities on the subject have estimated that from 15 to 20 times as much plant food is lost through erosion alone as is removed by crop production.

Even though Indiana farmers have made a large increase in the use of fertilizers in recent years, it is extremely unlikely they will be able to replace all the phosphate and potash that will be lost or removed this year, according to Mr. Baynes. With shortages of material and transportation and labor problems, farmers will be unable to apply to the land the equivalent of the plant food that will be removed through record crop production. In other words they will now have to draw on the bank account of soil fertility to produce the food and fiber needed to help win the war. He believes that every Hoosier farmer has an inherent desire to pass on his farm in as good or better condition than he received it, and that there is one real, all-American way to do it—to set aside part of the higher income rolling in now for war production for after-the-war soil rebuilding.

# Victory Gardens Second Round

Most of the Victory gardens are "in," and the thrill of the seed catalogs, exercise in the cool air of spring, and the fragrance of newly turned earth will soon be over for those to whom this is a new adventure. Now comes the second round—weeds and bugs, plus hot weather—when many good intentions will fall by the wayside. To further tempt those who find "the row hard going" will be the influx of fresh vegetables into urban markets.

The interest in gardens has been fresh and stimulating—a welcome relief to jaded nerves and worried discussions. There will be even more need for this relief in the critical days to come and it is to be hoped that everything possible to keep interest up to a productive pitch will be put forth by the experienced for the benefit of those who need their advice.

To Abraham Lincoln is credited the following, a good thought to pass along:

"No other human occupation opens so wide a field for the profitable and agreeable combination of labor with cultivated thought as agriculture. Every blade of grass is a study; and to produce two where there was but one is both a profit and a pleasure. The thought recurs that education—cultivated thought—can best be combined with agricultural labor, or any labor, on the principle of thorough work, and ere long the most valuable of all arts will be the art of deriving a comforable subsistence from the smallest area of soil."

# Farm Prices of Farm Products*

| | Cotton Cents per lb. | Tobacco Cents per lb. | Potatoes Cents per bu. | Sweet Potatoes Cents per bu. | Corn Cents per bu. | Wheat Cents per bu. | Hay Dollars per ton | Cottonseed Dollars per ton | Truck Crops |
|---|---|---|---|---|---|---|---|---|---|
| 1910–14 Average | 12.4 | 10.4 | 69.6 | 87.6 | 64.8 | 88.0 | 11.94 | 21.59 | .... |
| 1920 | 32.1 | 17.3 | 249.5 | 175.7 | 144.2 | 224.1 | 21.26 | 51.73 | .... |
| 1921 | 12.3 | 19.5 | 103.8 | 118.7 | 58.7 | 119.0 | 12.96 | 22.18 | .... |
| 1922 | 18.9 | 22.8 | 96.7 | 104.8 | 58.5 | 103.2 | 11.68 | 35.04 | .... |
| 1923 | 26.7 | 19.0 | 84.1 | 104.4 | 80.1 | 98.9 | 12.29 | 43.69 | .... |
| 1924 | 27.6 | 19.0 | 87.0 | 137.0 | 91.2 | 110.5 | 13.28 | 38.34 | .... |
| 1925 | 22.1 | 16.8 | 113.9 | 171.6 | 99.9 | 151.0 | 12.54 | 35.07 | .... |
| 1926 | 15.1 | 17.9 | 185.7 | 156.3 | 69.9 | 135.1 | 13.06 | 27.20 | .... |
| 1927 | 15.9 | 20.7 | 132.3 | 114.0 | 78.8 | 120.5 | 12.00 | 28.56 | .... |
| 1928 | 18.6 | 20.0 | 82.9 | 112.3 | 89.1 | 113.4 | 10.63 | 37.70 | .... |
| 1929 | 17.7 | 18.6 | 93.7 | 118.4 | 87.6 | 102.7 | 11.56 | 34.98 | .... |
| 1930 | 12.4 | 12.9 | 124.4 | 115.8 | 78.0 | 80.9 | 11.31 | 26.25 | .... |
| 1931 | 7.6 | 8.2 | 72.7 | 92.9 | 49.8 | 48.8 | 9.76 | 17.04 | .... |
| 1932 | 5.8 | 10.5 | 43.3 | 57.2 | 28.1 | 38.8 | .53 | 9.74 | .... |
| 1933 | 8.1 | 12.9 | 66.0 | 59.4 | 36.5 | 58.1 | 6.81 | 12.32 | .... |
| 1934 | 12.0 | 17.1 | 68.0 | 79.1 | 61.3 | 79.8 | 10.67 | 26.12 | .... |
| 1935 | 11.6 | 16.1 | 49.4 | 73.9 | 77.4 | 86.4 | 10.57 | 35.56 | .... |
| 1936 | 11.7 | 17.2 | 99.6 | 85.3 | 76.7 | 96.0 | 8.93 | 31.78 | .... |
| 1937 | 11.1 | 19.9 | 88.3 | 91.8 | 94.8 | 107.1 | 10.36 | 30.24 | .... |
| 1938 | 8.3 | 17.2 | 55.5 | 76.9 | 49.0 | 66.1 | 7.55 | 21.13 | ... |
| 1939 | 8.7 | 13.6 | 68.1 | 75.4 | 47.6 | 63.6 | 6.95 | 22.17 | .... |
| 1940 | 9.6 | 15.1 | 70.7 | 85.2 | 59.0 | 73.9 | 7.62 | 24.31 | .... |
| 1941 | 13.3 | 19.1 | 64.6 | 94.4 | 64.3 | 84.0 | 8.10 | 35.04 | .... |
| 1942 | 18.51 | 28.3 | 110.0 | 108.3 | 79.5 | 101.8 | 10.05 | 44.42 | .... |
| April | 19.03 | 12.7 | 116.2 | 102.4 | 79.7 | 99.7 | 11.13 | 43.90 | .... |
| May | 19.17 | 21.3 | 114.8 | 105.6 | 81.4 | 99.8 | 10.82 | 43.99 | .... |
| June | 18.26 | 30.2 | 111.1 | 108.6 | 81.9 | 95.7 | 10.00 | 43.87 | .... |
| July | 18.55 | 31.0 | 125.8 | 112.2 | 83.1 | 94.6 | 9.05 | 43.20 | .... |
| August | 18.03 | 33.5 | 115.4 | 137.3 | 83.4 | 95.4 | 8.89 | 44.04 | .... |
| September | 18.59 | 35.1 | 107.7 | 120.5 | 82.6 | 102.6 | 9.03 | 45.33 | .... |
| October | 18.87 | 42.3 | 102.5 | 107.9 | 77.5 | 103.5 | 9.39 | 46.46 | .... |
| November | 19.22 | 39.8 | 108.4 | 103.5 | 75.9 | 104.4 | 9.84 | 45.01 | .... |
| December | 19.55 | 40.0 | 111.8 | 110.3 | 80.2 | 110.3 | 10.46 | 44.72 | .... |
| 1943 | | | | | | | | | |
| January | 19.74 | 35.1 | 117.8 | 121.4 | 88.0 | 117.5 | 11.20 | 44.34 | .... |
| February | 19.68 | 18.2 | 125.7 | 129.8 | 90.4 | 119.5 | 11.94 | 44.88 | .... |
| March | 19.91 | 16.0 | 145.1 | 153.6 | 94.8 | 122.7 | 12.28 | 45.73 | .... |
| April | 20.13 | 16.0 | 166.8 | 179.2 | 100.2 | 122.3 | 12.61 | 45.89 | .... |

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| 1921 | 99 | 187 | 149 | 136 | 91 | 135 | 109 | 103 | .... |
| 1922 | 152 | 219 | 139 | 120 | 90 | 117 | 98 | 162 | .... |
| 1923 | 215 | 183 | 121 | 119 | 124 | 112 | 103 | 202 | .... |
| 1924 | 223 | 183 | 125 | 156 | 141 | 126 | 111 | 177 | 150 |
| 1925 | 178 | 161 | 164 | 196 | 154 | 172 | 105 | 162 | 153 |
| 1926 | 122 | 172 | 267 | 178 | 108 | 154 | 109 | 126 | 143 |
| 1927 | 128 | 199 | 190 | 130 | 122 | 137 | 101 | 132 | 121 |
| 1928 | 150 | 192 | 119 | 128 | 138 | 129 | 89 | 175 | 159 |
| 1929 | 143 | 179 | 135 | 135 | 135 | 117 | 97 | 162 | 149 |
| 1930 | 100 | 124 | 179 | 132 | 120 | 92 | 95 | 122 | 140 |
| 1931 | 61 | 79 | 104 | 106 | 77 | 55 | 82 | 79 | 117 |
| 1932 | 47 | 101 | 62 | 65 | 43 | 44 | 63 | 45 | 102 |
| 1933 | 65 | 124 | 95 | 68 | 56 | 66 | 57 | 57 | 105 |
| 1934 | 97 | 164 | 98 | 90 | 95 | 91 | 89 | 121 | 104 |
| 1935 | 94 | 155 | 71 | 84 | 119 | 98 | 89 | 165 | 126 |
| 1936 | 94 | 165 | 143 | 97 | 118 | 109 | 75 | 147 | 113 |
| 1937 | 90 | 191 | 127 | 105 | 146 | 122 | 87 | 140 | 122 |
| 1938 | 67 | 165 | 80 | 88 | 76 | 75 | 63 | 98 | 101 |
| 1939 | 70 | 131 | 98 | 86 | 73 | 72 | 58 | 103 | 109 |
| 1940 | 78 | 145 | 102 | 97 | 91 | 84 | 64 | 126 | 121 |
| 1941 | 107 | 184 | 93 | 108 | 99 | 95 | 68 | 162 | 145 |
| 1942 | 149 | 272 | 158 | 124 | 123 | 116 | 84 | 206 | 199 |
| April | 153 | 122 | 167 | 117 | 123 | 113 | 93 | 203 | 158 |
| May | 155 | 205 | 165 | 121 | 126 | 113 | 91 | 204 | 152 |
| June | 147 | 290 | 160 | 124 | 126 | 109 | 84 | 203 | 169 |
| July | 150 | 298 | 181 | 128 | 128 | 108 | 76 | 200 | 200 |
| August | 145 | 322 | 166 | 157 | 129 | 108 | 74 | 204 | 256 |
| September | 150 | 338 | 155 | 138 | 127 | 117 | 76 | 210 | 191 |
| October | 152 | 407 | 147 | 123 | 120 | 118 | 79 | 215 | 226 |
| November | 155 | 383 | 156 | 118 | 117 | 119 | 82 | 208 | 238 |
| December | 158 | 385 | 161 | 126 | 124 | 125 | 88 | 207 | 293 |
| 1943 | | | | | | | | | |
| January | 159 | 338 | 169 | 139 | 136 | 134 | 94 | 205 | 277 |
| February | 159 | 175 | 181 | 148 | 140 | 136 | 100 | 208 | 301 |
| March | 161 | 154 | 208 | 175 | 146 | 139 | 103 | 212 | 302 |
| April | 162 | 154 | 240 | 205 | 155 | 139 | 106 | 213 | 291 |

# Wholesale Prices of Ammoniates

| | Nitrate of soda per unit N bulk | Sulphate of ammonia bulk per unit N | Cottonseed meal S. E. Mills per unit N | Fish scrap, dried 11-12% ammonia, 15% bone phosphate, f.o.b. factory, bulk per unit N | Fish scrap, wet acidulated, 6% ammonia, 3% bone phosphate, f.o.b. factory, bulk per unit N | Tankage 11% ammonia, 15% bone phosphate, f.o.b. Chicago, bulk, per unit N | High grade ground blood, 16-17% ammonia, Chicago, bulk, per unit N |
|---|---|---|---|---|---|---|---|
| 1910–14 | $2.68 | $2.85 | $3.50 | $3.53 | $3.05 | $3.37 | $3.52 |
| 1922 | 3.04 | 2.58 | 6.07 | 4.66 | 3.54 | 4.75 | 4.99 |
| 1923 | 3.02 | 2.90 | 6.19 | 4.83 | 4.25 | 4.59 | 5.16 |
| 1924 | 2.99 | 2.44 | 5.87 | 5.02 | 4.41 | 3.60 | 4.25 |
| 1925 | 3.11 | 2.47 | 5.41 | 5.34 | 4.71 | 3.97 | 4.75 |
| 1926 | 3.06 | 2.41 | 4.40 | 4.95 | 4.15 | 4.36 | 4.90 |
| 1927 | 3.01 | 2.26 | 5.07 | 5.87 | 4.35 | 4.32 | 5.70 |
| 1928 | 2.67 | 2.30 | 7.06 | 6.63 | 5.28 | 4.92 | 6.00 |
| 1929 | 2.57 | 2.04 | 5.64 | 5.00 | 4.69 | 4.61 | 5.72 |
| 1930 | 2.47 | 1.81 | 4.78 | 4.96 | 4.15 | 3.79 | 4.58 |
| 1931 | 2.34 | 1.46 | 3.10 | 3.95 | 3.33 | 2.11 | 2.46 |
| 1932 | 1.87 | 1.04 | 2.18 | 2.18 | 1.82 | 1.21 | 1.36 |
| 1933 | 1.52 | 1.12 | 2.95 | 2.86 | 2.58 | 2.06 | 2.46 |
| 1934 | 1.52 | 1.20 | 4.46 | 3.15 | 2.84 | 2.67 | 3.27 |
| 1935 | 1.47 | 1.15 | 4.59 | 3.10 | 2.65 | 3.06 | 3.65 |
| 1936 | 1.53 | 1.23 | 4.17 | 3.42 | 2.67 | 3.58 | 4.25 |
| 1937 | 1.63 | 1.32 | 4.91 | 4.66 | 3.65 | 4.04 | 4.30 |
| 1938 | 1.69 | 1.38 | 3.69 | 3.76 | 3.17 | 3.15 | 3.53 |
| 1939 | 1.69 | 1.35 | 4.02 | 4.41 | 3.12 | 3.87 | 3.90 |
| 1940 | 1.69 | 1.36 | 4.64 | 4.36 | 3.35 | 3.33 | 3.39 |
| 1941 | 1.69 | 1.41 | 5.50 | 5.32 | 3.27 | 3.76 | 4.43 |
| 1942 | 1.74 | 1.41 | 6.11 | 5.77 | 3.34 | 5.04 | 6.76 |
| April | 1.75 | 1.41 | 6.48 | 5.77 | 3.34 | 5.46 | 6.80 |
| May | 1.75 | 1.41 | 6.29 | 5.77 | 3.34 | 5.46 | 6.97 |
| June | 1.75 | 1.41 | 5.23 | 5.77 | 3.34 | 4.98 | 6.94 |
| July | 1.75 | 1.41 | 5.99 | 5.77 | 3.34 | 4.86 | 6.80 |
| August | 1.75 | 1.42 | 5.77 | 5.77 | 3.34 | 4.86 | 6.94 |
| September | 1.75 | 1.42 | 5.69 | 5.77 | 3.34 | 4.86 | 6.97 |
| October | 1.75 | 1.42 | 5.72 | 5.77 | 3.34 | 4.86 | 6.80 |
| November | 1.75 | 1.42 | 6.06 | 5.77 | 3.34 | 4.86 | 6.53 |
| December | 1.75 | 1.42 | 5.68 | 5.77 | 3.34 | 4.86 | 6.53 |
| 1943 | | | | | | | |
| January | 1.75 | 1.42 | 5.68 | 5.77 | 3.34 | 4.86 | 6.53 |
| February | 1.75 | 1.42 | 5.83 | 5.77 | 3.34 | 4.86 | 6.53 |
| March | 1.75 | 1.42 | 6.30 | 5.77 | 3.34 | 4.86 | 6.53 |
| April | 1.75 | 1.42 | 6.29 | 5.77 | 3.34 | 4.86 | 6.53 |

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| 1922 | 113 | 90 | 173 | 132 | 117 | 140 | 142 |
| 1923 | 112 | 102 | 177 | 137 | 140 | 136 | 147 |
| 1924 | 111 | 86 | 168 | 142 | 145 | 107 | 121 |
| 1925 | 115 | 87 | 155 | 151 | 155 | 117 | 135 |
| 1926 | 113 | 84 | 126 | 140 | 136 | 129 | 139 |
| 1927 | 112 | 79 | 145 | 166 | 143 | 128 | 162 |
| 1928 | 100 | 81 | 202 | 188 | 173 | 146 | 170 |
| 1929 | 96 | 72 | 161 | 142 | 154 | 137 | 162 |
| 1930 | 92 | 64 | 137 | 141 | 136 | 112 | 130 |
| 1931 | 88 | 51 | 89 | 112 | 109 | 63 | 70 |
| 1932 | 71 | 36 | 62 | 62 | 60 | 36 | 39 |
| 1933 | 59 | 39 | 84 | 81 | 85 | 97 | 71 |
| 1934 | 59 | 42 | 127 | 89 | 93 | 79 | 93 |
| 1935 | 57 | 40 | 131 | 88 | 87 | 91 | 104 |
| 1936 | 59 | 43 | 119 | 97 | 89 | 106 | 121 |
| 1937 | 61 | 46 | 140 | 132 | 120 | 120 | 122 |
| 1938 | 63 | 48 | 105 | 106 | 104 | 93 | 100 |
| 1939 | 63 | 47 | 115 | 125 | 102 | 115 | 111 |
| 1940 | 63 | 48 | 133 | 124 | 110 | 99 | 96 |
| 1941 | 63 | 49 | 157 | 151 | 107 | 112 | 126 |
| 1942 | 65 | 49 | 175 | 163 | 110 | 150 | 192 |
| April | 65 | 49 | 185 | 163 | 110 | 162 | 193 |
| May | 65 | 49 | 180 | 163 | 110 | 162 | 198 |
| June | 65 | 49 | 149 | 163 | 110 | 148 | 197 |
| July | 65 | 49 | 171 | 163 | 110 | 144 | 193 |
| August | 65 | 50 | 165 | 163 | 110 | 144 | 197 |
| September | 65 | 50 | 163 | 163 | 110 | 144 | 198 |
| October | 65 | 50 | 163 | 163 | 110 | 144 | 193 |
| November | 65 | 50 | 173 | 163 | 110 | 144 | 186 |
| December | 65 | 50 | 162 | 163 | 110 | 144 | 186 |
| 1943 | | | | | | | |
| January | 65 | 50 | 162 | 163 | 110 | 144 | 186 |
| February | 65 | 50 | 167 | 163 | 110 | 144 | 186 |
| March | 65 | 50 | 180 | 163 | 110 | 144 | 186 |
| April | 65 | 50 | 180 | 163 | 110 | 144 | 186 |

# Wholesale Prices of Phosphates and Potash**

| | Superphosphate Baltimore, per unit | Florida land pebble, 68% f.o.b. mines, bulk, per ton | Tennessee phosphate rock, 75% f.o.b. mines, bulk, per ton | Muriate of potash bulk, per unit, c.i.f. Atlantic and Gulf ports | Sulphate of potash in bags, per unit, c.i.f. Atlantic and Gulf ports | Sulphate of potash magnesia, per ton, c.i.f. Atlantic and Gulf ports | Manure salts bulk, per unit, c.i.f. Atlantic and Gulf ports[1] | Kainit, 20% bulk, per unit, c.i.f. Atlantic and Gulf ports[1] |
|---|---|---|---|---|---|---|---|---|
| 1910–14 | $0.536 | $3.61 | $4.88 | $0.714 | $0.953 | $24.18 | $0.657 | $0.655 |
| 1922 | .566 | 3.12 | 6.90 | .632 | .904 | 23.87 | .... | .508 |
| 1923 | .550 | 3.08 | 7.50 | .588 | .836 | 23.32 | .... | .474 |
| 1924 | .502 | 2.31 | 6.60 | .582 | .860 | 23.72 | .... | .472 |
| 1925 | .600 | 2.44 | 6.16 | .584 | .860 | 23.72 | .... | .483 |
| 1926 | .598 | 3.20 | 5.57 | .596 | .854 | 23.58 | .537 | .524 |
| 1927 | .535 | 3.09 | 5.50 | .646 | .924 | 25.55 | .586 | .581 |
| 1928 | .580 | 3.12 | 5.50 | .669 | .957 | 26.46 | .607 | .602 |
| 1929 | .609 | 3.18 | 5.50 | .672 | .962 | 26.59 | .610 | .605 |
| 1930 | .542 | 3.18 | 5.50 | .681 | .973 | 26.92 | .618 | .612 |
| 1931 | .485 | 3.18 | 5.50 | .681 | .973 | 26.92 | .618 | .612 |
| 1932 | .458 | 3.18 | 5.50 | .681 | .963 | 26.90 | .618 | .591 |
| 1933 | .434 | 3.11 | 5.50 | .662 | .864 | 25.10 | .601 | .565 |
| 1934 | .487 | 3.14 | 5.67 | .486 | .751 | 22.49 | .483 | .471 |
| 1935 | .492 | 3.30 | 5.69 | .415 | .684 | 21.44 | .444 | .488 |
| 1936 | .476 | 1.85 | 5.50 | .464 | .708 | 22.94 | .505 | .560 |
| 1937 | .510 | 1.85 | 5.50 | .508 | .757 | 24.70 | .556 | .607 |
| 1938 | .492 | 1.85 | 5.50 | .523 | .774 | 25.17 | .572 | .623 |
| 1939 | .478 | 1.90 | 5.50 | .521 | .751 | 24.52 | .570 | .607 |
| 1940 | .516 | 1.90 | 5.50 | .517 | .730 | .... | .573 | .... |
| 1941 | .547 | 1.94 | 5.64 | .522 | .748 | 25.55 | .570 | .... |
| 1942 | .600 | 2.13 | 6.29 | .522 | .748 | 25.74 | .205 | ... |
| April | .600 | 2.20 | 6.50 | .535 | .755 | 26.00 | .210 | .... |
| May | .600 | 2.20 | 6.50 | .535 | .755 | 26.00 | .210 | .... |
| June | .600 | 2.20 | 6.50 | .471 | .665 | 22.88 | .185 | .... |
| July | .600 | 2.20 | 6.50 | .503 | .755 | 26.00 | .197 | .... |
| August | .600 | 2.20 | 6.50 | .503 | .755 | 26.00 | .197 | .... |
| September | .600 | 2.20 | 6.50 | .503 | .755 | 26.00 | .197 | .... |
| October | .600 | 2.10 | 6.20 | .535 | .755 | 26.00 | .210 | .... |
| November | .600 | 2.00 | 5.90 | .535 | .755 | 26.00 | .210 | .... |
| December | .600 | 2.00 | 5.90 | .535 | .755 | 26.00 | .210 | .... |
| 1943 | | | | | | | | |
| January | .600 | 2.00 | 5.90 | .535 | .755 | 26.00 | .210 | .... |
| February | .600 | 2.00 | 5.90 | .535 | .755 | 26.00 | .210 | .... |
| March | .608 | 2.00 | 5.90 | .535 | .755 | 26.00 | .210 | .... |
| April | .640 | 2.00 | 5.90 | .535 | .755 | 26.00 | .210 | .... |

## Index Numbers (1910-14 = 100)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1922 | 106 | 87 | 141 | 89 | 95 | 99 | .... | 78 |
| 1923 | 103 | 85 | 154 | 82 | 88 | 96 | .... | 72 |
| 1924 | 94 | 64 | 135 | 82 | 90 | 98 | .... | 72 |
| 1925 | 110 | 68 | 126 | 82 | 90 | 98 | .... | 74 |
| 1926 | 112 | 88 | 114 | 83 | 90 | 98 | 82 | 80 |
| 1927 | 100 | 86 | 113 | 90 | 97 | 106 | 89 | 89 |
| 1928 | 108 | 86 | 113 | 94 | 100 | 109 | 92 | 92 |
| 1929 | 114 | 88 | 113 | 94 | 101 | 110 | 93 | 92 |
| 1930 | 101 | 88 | 113 | 95 | 102 | 111 | 94 | 93 |
| 1931 | 90 | 88 | 113 | 95 | 102 | 111 | 94 | 93 |
| 1932 | 85 | 88 | 113 | 95 | 101 | 111 | 94 | 90 |
| 1933 | 81 | 86 | 113 | 93 | 91 | 104 | 91 | 86 |
| 1934 | 91 | 87 | 116 | 68 | 79 | 93 | 74 | 72 |
| 1935 | 92 | 91 | 117 | 58 | 72 | 89 | 68 | 75 |
| 1936 | 89 | 51 | 113 | 65 | 74 | 95 | 77 | 85 |
| 1937 | 95 | 51 | 113 | 71 | 79 | 102 | 85 | 93 |
| 1938 | 92 | 51 | 113 | 73 | 81 | 104 | 87 | 95 |
| 1939 | 89 | 53 | 113 | 73 | 79 | 101 | 87 | 93 |
| 1940 | 96 | 53 | 113 | 72 | 77 | .... | 87 | .... |
| 1941 | 102 | 54 | 116 | 73 | 78 | 106 | 87 | .... |
| 1942 | 112 | 59 | 129 | 73 | 78 | 106 | 84 | .... |
| April | 112 | 61 | 133 | 75 | 79 | 108 | 85 | .... |
| May | 112 | 61 | 133 | 75 | 79 | 108 | 85 | .... |
| June | 112 | 61 | 133 | 66 | 70 | 95 | 81 | .... |
| July | 112 | 61 | 133 | 70 | 79 | 108 | 83 | .... |
| August | 112 | 61 | 133 | 70 | 79 | 108 | 83 | .... |
| September | 112 | 61 | 133 | 70 | 79 | 108 | 83 | .... |
| October | 112 | 58 | 127 | 75 | 79 | 108 | 85 | .... |
| November | 112 | 55 | 121 | 75 | 79 | 108 | 85 | .... |
| December | 112 | 55 | 121 | 75 | 79 | 108 | 85 | .... |
| 1943 | | | | | | | | |
| January | 112 | 55 | 121 | 75 | 79 | 108 | 85 | .... |
| February | 112 | 55 | 121 | 75 | 79 | 108 | 85 | .... |
| March | 113 | 55 | 121 | 75 | 79 | 108 | 85 | .... |
| April | 119 | 55 | 121 | 75 | 79 | 108 | 85 | .... |

# Combined Index Numbers of Prices of Fertilizer Materials, Farm Products and All Commodities

| | Farm prices* | Prices paid by farmers for commodities bought* | Wholesale prices of all commodities† | Fertilizer materials‡ | Chemical ammoniates | Organic ammoniates | Superphosphate | Potash |
|---|---|---|---|---|---|---|---|---|
| 1922 | 132 | 149 | 141 | 116 | 101 | 145 | 106 | 85 |
| 1923 | 142 | 152 | 147 | 114 | 107 | 144 | 103 | 79 |
| 1924 | 143 | 152 | 143 | 103 | 97 | 125 | 94 | 79 |
| 1925 | 156 | 157 | 151 | 112 | 100 | 131 | 109 | 80 |
| 1926 | 145 | 155 | 146 | 119 | 94 | 135 | 112 | 86 |
| 1927 | 139 | 153 | 139 | 116 | 89 | 150 | 100 | 94 |
| 1928 | 149 | 155 | 141 | 121 | 87 | 177 | 108 | 97 |
| 1929 | 146 | 153 | 139 | 114 | 79 | 146 | 114 | 97 |
| 1930 | 126 | 145 | 126 | 105 | 72 | 131 | 101 | 99 |
| 1931 | 87 | 124 | 107 | 83 | 62 | 83 | 90 | 99 |
| 1932 | 65 | 107 | 95 | 71 | 46 | 48 | 85 | 99 |
| 1933 | 70 | 109 | 96 | 70 | 45 | 71 | 81 | 95 |
| 1934 | 90 | 123 | 109 | 72 | 47 | 90 | 91 | 72 |
| 1935 | 108 | 125 | 117 | 70 | 45 | 97 | 92 | 63 |
| 1936 | 114 | 124 | 118 | 73 | 47 | 107 | 89 | 69 |
| 1937 | 121 | 130 | 126 | 81 | 50 | 129 | 95 | 75 |
| 1938 | 95 | 122 | 115 | 78 | 52 | 101 | 92 | 77 |
| 1939 | 93 | 121 | 112 | 79 | 51 | 119 | 89 | 77 |
| 1940 | 98 | 122 | 115 | 80 | 52 | 114 | 96 | 77 |
| 1941 | 122 | 130 | 127 | 86 | 56 | 130 | 102 | 76 |
| 1942 | 157 | 152 | 144 | 92 | 57 | 161 | 112 | 76 |
| April | 150 | 151 | 144 | 94 | 57 | 171 | 112 | 78 |
| May | 152 | 152 | 144 | 94 | 57 | 169 | 112 | 78 |
| June | 151 | 152 | 144 | 90 | 57 | 151 | 112 | 69 |
| July | 154 | 152 | 144 | 91 | 57 | 157 | 112 | 74 |
| August | 163 | 153 | 145 | 91 | 57 | 155 | 112 | 74 |
| September | 163 | 154 | 145 | 91 | 57 | 154 | 112 | 74 |
| October | 169 | 155 | 145 | 92 | 57 | 154 | 112 | 78 |
| November | 169 | 156 | 146 | 92 | 57 | 158 | 112 | 78 |
| December | 178 | 158 | 147 | 92 | 57 | 154 | 112 | 78 |
| 1943 | | | | | | | | |
| January | 182 | 160 | 149 | 92 | 57 | 154 | 112 | 78 |
| February | 178 | 162 | 149 | 92 | 57 | 155 | 112 | 78 |
| March | 182 | 163 | 150 | 93 | 57 | 160 | 113 | 78 |
| April | 185 | 165 | 151 | 95 | 57 | 160 | 119 | 78 |

* U. S. D. A. figures.

† Department of Labor index converted to 1910-14 base.

‡ The Index numbers of prices of fertilizer materials are based on original study made by the Department of Agricultural Economics and Farm Management, Cornell University, Ithaca, New York. These indexes are complete since 1897. The series was revised and reweighted as of March 1940 and November 1942.

[1] Beginning with June 1941, manure salts prices are F. O. B. mines, the only basis now quoted.

**** The annual average of potash prices is higher than the weighted average of prices actually paid because since 1926 better than 90% of the potash used in agriculture has been contracted for during the discount period. From 1937 on, the maximum seasonal discount has been 12%.**

# REVIEWS

**This section contains a short review of some of the most practical and important bulletins, and lists all recent publications of the United States Department of Agriculture, the State Experiment Stations, and Canada, relating to Fertilizers, Soils, Crops, and Economics. A file of this department of BETTER CROPS WITH PLANT FOOD would provide a complete index covering all publications from these sources on the particular subjects named.**

## Fertilizers

¶ Under the necessity of obtaining more exact information on fertilizer usage in connection with war programs in this country, nearly all if not all states are now compiling the best information available on tonnages of the various grades of fertilizer use. Data from three states are listed this month. "Fertilizer Sales in Ohio-1942", compiled by the Agronomy Department of Ohio State University, showed that more than 412,000 tons of fertilizer were used in the State during the year. Nearly 80% of the tonnage was composed of standard and multiple strength analyses. The leading fertilizer grades on the basis of tonnage were 2-12-6, 0-14-7, 0-12-12, 0-20-0, 3-12-12, and 3-18-9. About 61% of the total tonnage is used in the spring with the remainder used in the fall season.

¶ The Soil Science Department of Michigan State College issued mimeograph sheet entitled "Tonnage of Different Grades of Fertilizer Sold in Michigan 1942." More than 187,000 tons of fertilizer were sold in the State during the year; 75% of the sales were in the spring, the remainder in the fall. Over 98% of the mixed goods contained 20% or more plant food, representing a steady increase from 72.7% of the total in 1934. The leading analyses, in order, were 2-12-6, 0-14-7, 0-20-0, 0-12-12, 2-16-8, 3-12-12, 0-8-24, 0-20-20, and 3-9-18.

¶ Ford S. Prince has issued the data for New Hampshire under the title, "Grade Survey-Fiscal Year 1942, New Hampshire." This shows that the total fertilizer sales in the State were 16,609 tons, with 12,000 tons in addition applied by the Agricultural Conservation Program, making a grand total of 28,600 tons consumed in the State. The leading analysis was 5-8-7, followed by 4-8-10, 0-20-0, nitrate of soda, and 7-7-7. The other grades were much less in tonnage.

*"Bureau of Chemistry Announcement Nos. FM-59 and FM-60," Dept. of Agr., Sacramento, California, March 1943.*

*"Fertilizer, Seed and Ice Cream Report, July-December 1942," State Board of Agriculture, Dover, Delaware, December 31, 1942.*

*"Restrictions and Suggestions for Wartime Fertilizer Practices," Dept. of Agron., Ext. Serv., Univ. of Ill., Urbana, Ill., AG-1126, Feb. 1943, A. L. Lang.*

*"Fertilizer Consumption in Iowa 1942," Dept. of Agron., Iowa College of Agriculture, Ames, Iowa.*

*"Family War Gardens," Ext. Serv., Univ. of Maine, Orono, Maine, E. Cir. 174, March 1943.*

*"Tonnage of Different Grades of Fertilizer Sold in Michigan 1942," Soils Science Dept., Mich. State College, East Lansing, Mich.*

*"Fertilizer Analyses and Registrations," Dept. of Agr., State of Minn., St. Paul, Minn., 1942, H. A. Halvorson.*

*"Grade Survey-Fiscal Year 1942," Agr. Exp. Sta., Durham, N. H., Ford S. Prince.*

*"Wartime Fertilizers for New Jersey," Agr. Exp. Sta., Rutgers Univ., New Brunswick, N. J., Cir. 456, March 1, 1943. (Rev. of Cir. 452, Oct. 1942.)*

*"Fertilizing Potatoes in 1943," N. Y. State College of Agr., Cornell Univ., Ithaca, N. Y., Bul. 551, War E. Bul. 58, Dec. 1942, Ora Smith.*

*"Fertilizing Vegetables in 1943," N. Y. State College of Agr., Cornell Univ., Ithaca, N. Y., Bul. 557, War E. Bul. 61, Jan. 1943, G. J. Raleigh and R. D. Sweet.*

*"Boron Investigations on Alfalfa," Dept. of Agron., Exp. Sta., Raleigh, N. C., 1943.*

*"Fertilizer Sales in Ohio—1942," Dept. of Agron., Ohio State Univ., Columbus, Ohio.*

*"Wartime Use of Fertilizers and Lime," Dept. of Soils, Univ. of Wis., Madison, Wis., C. J. Chapman and Emil Truog.*

**Soils**

¶ Information on potash relationships in orchard soils, and trees growing on them, is given by Walter Reuther in Cornell University Agricultural Experiment Station Memoir 241, entitled, "Studies Concerning the Supply of Available Potassium in Certain New York Orchard Soils." A review of literature on the effects of potash fertilization on fruit trees shows conflicting results with benefit from potash fertilization. Response to potash on fruits is commonly reported from England and Continental Europe.

English literature by Wallace and others furnished descriptions of leaf defects, known as leaf scorch, which were associated with fruit trees responding to potash.

Some of these investigators found that the potassium content of tissue, and especially leaves, could be correlated with the available potassium content of the medium in which the trees were growing.

Leaf scorch, as found in some of the orchards of New York State, is described and illustrated.

Soil and leaf samples from apple, prune, and cherry orchards affected with leaf scorch were analyzed for potassium and results compared with samples taken from apparently healthy orchards. Foliage from trees affected with leaf scorch contained only one-half to one-third as much potassium as foliage from healthy vigorous trees. Spur leaves tended to be lower in potassium than shoot leaves. Soil samples from orchards affected with leaf scorch were also low in available potassium. The data show that in soils from orchards affected with leaf scorch available potash, as measured by the Neubauer rye-seedling method, sometimes was lower than exchangeable potassium. It would appear as if in some soils, much of the exchangeable potassium is not available to rye seedlings and fruit trees.

The application of potash fertilizer at 1 to 3 lbs. per tree largely corrected the leaf-scorch condition and increased the potassium content of the leaves, but did not increase trunk growth to any measurable extent in one year. Manure also was effective.

Apple seedlings were grown in the greenhouse. In most of the soils used, the seedlings responded significantly in growth to potash fertilization. Top soils usually produced larger plants than sub-soils, and soils with poorest growth without potash tended to respond more to potash fertilization. Root-top ratios of the seedlings were not much affected by potash treatment. Application of potash resulted in higher potassium content in leaves of plants.

The author concludes that leaf scorch as found in New York orchards is similar to this disorder in other parts of the world. The difficulty appears to be due to potassium deficiency in the tree and may be corrected by applying potash to the soil. He believes that soil tests and leaf analysis may be used as a general guide to the likelihood of response to potash fertilization on fruit trees.

*"Drainage Water Losses From a Sandy Soil as Affected by Cropping and Cover Crops," Agr. Exp. Sta., New Haven, Conn., Bul. 466, Oct. 1942, M. F. Morgan, H. G. M. Jacobson, and S. B. LeCompte, Jr.*

*"Results of Rapid Chemical Tests on Delaware Soils," Dept. of Agron., Agr. Exp. Sta., Univ. of Del., Pamphlet No. 7, March 1943, Henry C. Harris.*

*"Water Control in the Peat and Muck Soils of the Florida Everglades," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Bul. 378, Nov. 1942, B. S. Clayton, J. R. Neller, and R. V. Allison.*

*"Minor Elements Stimulate Pasture Plants," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Bul. 384, March 1943, G. B. Killinger, R. E. Blaser, E. M. Hodges, and W. E. Stokes.*

*"Dade County, Georgia, Soil Survey," U. S. D. A., Washington, D. C., Series 1936, No. 20, Oct. 1942, Arthur E. Taylor, J. C. Mercer, J. T. Conger, and G. D. Thornton.*

*"Muck Soil Management for Sugar Beet Production," Agr. Exp. Sta., Mich. State College, East Lansing, Mich., Cir. Bul. 187, April 1943, Paul M. Harmer.*

*"Investigations in Erosion Control and Re-*

*clamation of Eroded Land at the Red Plains Conservation Experiment Station, Guthrie, Okla. 1930-40," U. S. D. A., Soil Conservation Service, Washington, D. C., Tech. Bul. 837, Jan. 1943, Harley A. Daniel, Harry M. Elwell, and Maurice B. Cox.*

## Crops

¶ Information on the preparation and care of a garden is presented in an unusual but effective way in North Carolina Agricultural Extension Circular 261, "Garden Guide," by L. P. Watson. The various steps in preparing the soil, applying the fertilizer, planting the seed, transplanting plants, training them, cultivating, and harvesting are covered by a series of excellent photographs with a short legend accompanying each. It is difficult to imagine a better method for telling inexperienced gardeners how to go about the job than by showing them the actual operation. Since this usually is not practical, a good picture is the next best thing. This circular should prove very helpful in the victory garden program.

¶ Under war conditions, hemp has become a very important crop in providing strong fiber which formerly was imported. While some hemp always has been grown in this country, a greatly increased acreage and production are desired during the coming year. This increased acreage is expected to be in the corn belt states, since the soils and climate in this area are well adapted to growing the crop. In order to provide information on hemp growing and handling, the Illinois, Iowa, and Minnesota Experiment Stations have issued bulletins dealing with this crop. The Illinois publication is Illinois Extension Circular 547 "Hemp An Illinois War Crop" by J. C. Hackleman and W. E. Domingo. The other publications are Iowa Extension Bulletin P49 by C. P. Wilsie, E. S. Dyas, and A. G. Norman, entitled "Hemp A War Crop for Iowa"; and Minnesota Extension Pamphlet 117 by A. C. Arny and R. F. Crim, entitled "Wartime Hemp Production in Minnesota." All three publications cover the same general fields and point out that hemp is best adapted to dark, fertile soils that are well drained. The crop closely resembles corn in its nutrient requirement, and the fertilization of the crop can well be similar to that for corn, although possibly on a slightly higher level. Manure applied to the crop preceding hemp is usually beneficial, while the hemp crop itself usually responds well to 200 to 300 lbs. per acre of fertilizer such as 3-18-9, 3-12-12, 0-12-12, or 0-10-20. In the rotation, the crop may well follow corn or a legume, but in general it is inadvisable to plant it after grain unless the grain has been seeded to a legume catch crop which was turned under. These bulletins also give information on seeding, harvesting, and handling.

*"Fifty-Fifth Annual Report," Agr. Exp. Sta., Colo. State College, Fort Collins, Colo., 1941-42.*

*"Starting Vegetable Plants," Agr. Exp. Sta., Colo. State College, Fort Collins, Colo., Bul. 475, Feb. 1943, A. M. Binkley.*

*"Annual Report of the Director," Agr. Exp. Sta., Univ. of Del., Newark, Del., Bul. 238, Nov. 1942.*

*"Pasture Fertilization and Management," Ext. Serv., State of Del., Newark, Del., Mimeo Cir. 18, March 1943, C. E. Phillips.*

*"Annual Hay and Pasture Crops," Ext. Serv., Newark, Del., Mimeo Cir. 22, April 1943, C. E. Phillips.*

*"Orchids in Florida," Ext. Serv., Gainesville, Fla., Bul. 116, Nov. 1942, John V. Watkins.*

*"The Florida Home Garden," Ext. Serv., Univ. of Fla., Gainesville, Fla., Bul. 119, Feb. 1943, F. S. Jamison.*

*"Planting Charts for Home Gardens," Agr. Ext. Serv., Gainesville, Fla., Cir. 65, Feb. 1943, J. S. Jamison.*

*"Guide to Disease Control in the Home Vegetable Garden," Ext. Serv., Univ. of Fla., Gainesville, Fla., Cir. 67, Feb. 1943, George F. Weber.*

*"Disease of Dent Corn in Indiana," Agr. Exp. Sta., Purdue Univ., Lafayette, Ind., Cir. 280, Jan. 1943, Arnold J. Ullstrup.*

*"Planting and Care of the Lawn," Agr. Ext. Serv., Univ. of Ky., Lexington, Ky., E. Cir. 381 (Rev. of Cir. 256), June 1942, N. R. Elliott.*

*"The 4-H Vegetable Garden," Ext. Serv., Univ. of Maine, Orono, Maine, E. Bul. 312, Dec. 1942, Oscar L. Wyman and William S. Plumer.*

*"Ladino Clover," Ext. Serv., Univ. of Maine, Orono, Maine, E. Cir. 172, March 1943.*

*"Information Available to Potato Growers," Agr. Ext. Serv., Univ. of Maine, Orono, Maine, E. Cir. 173, Feb. 1943.*

*"Increasing Milk Production on Dairy Farms*

*in Maine," Agr. Ext. Serv., Univ. of Maine, Orono, Maine, E. Cir. 176, March 1943.*

*"Potatoes are Essential War Crop," Agr. Ext. Serv., Univ of Maine, Orono, Maine, E. Cir. 177, March 1943.*

*"Victory Gardens," Ext. Serv., Univ. of Md., College Park, Md., Bul. 94, March 1943.*

*"Good Pastures For Poultry," Ext. Serv., Univ. of Md., College Park, Md., E. Bul. 95, Dec. 1942, Morley A. Jull and Wade H. Rice.*

*"Wartime Production of Vegetable Crops on Muck Land," Ext. Serv., Mich. State College, East Lansing, Mich., E. Bul. 244, Feb. 1943, Paul M. Harmer.*

*"Vegetable Gardening," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., E. Bul. 174, Rev. March 1943, A. E. Hutchins.*

*"Improved Varieties of Farm Crops," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., E. Folder 22, Rev. March 1943.*

*"Pasture Renovation," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., E. Folder 115, March 1943, Paul M. Burson and Ralph F. Crim.*

*"Garden Suggestions for Schools," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., E. Pamphlet 120, March 1943.*

*"Victory Garden," Agr. Ext. Serv., Univ. of Minn., St. Paul, Minn., E. Pamphlet 122, March 1943, E. M. Hunt and A. E. Hutchins.*

*"Bush Fruits in the Home Garden," Agr. Exp. Sta., Rutgers Univ., New Brunswick, N. J., Cir. 444, March 1943, J. V. Patterson.*

*"Growing More Feed," Agr. Exp. Sta., Rutgers Univ., New Brunswick, N. J., Cir. 453, January 1943, Gilbert H. Ahlgren.*

*"Thirteenth Annual Report of the New Mexico Feed and Fertilizer Control Office, Commercial Fertilizers," N. Mex. Feed and Fert. Control Office, State College, N. Mex., R. W. Ludwick and Lewis T. Elliott.*

*"Orchard Culture to Meet the Nitrogen Shortage," Ext. Serv., Cornell Univ., Ithaca, N. Y., Bul. 550, War E. Bul. 57, Dec. 1942, Damon Boynton.*

*"Producing Peanuts for Oil," Agr. Ext. Serv., State College Station, Raleigh, N. C., War Series Bul. 17, Feb. 1943.*

*"Farming for Victory and Peace," Agr. Ext. Serv., Univ. of Tenn., Knoxville, Tenn., Pub. 263, June 1942.*

*"Soybean Seed Production in Tennessee," Agr. Ext. Serv., Univ. of Tenn., Knoxville, Tenn., Agron. V. Cir. 4, March 1943, H. E. Hendricks.*

*"Row Gardens for Young Americans," Agr. Ext. Serv., Univ. of Tenn., Knoxville, Tenn., Leaflet No. 10 (Sp. Cir. 157 Rev.), March 1942.*

*"Growing Less Familiar Vegetables," Agr. Ext. Serv., Univ. of Tenn., Knoxville, Tenn., Leaflet No. 11, June 1942, W. C. Pelton.*

*"Strawberries in Farm Gardens," Agr. Ext. Serv., Univ. of Tenn., Knoxville, Tenn., Leaflet No. 21, (Pub. 158 Rev.), April 1942, W. C. Pelton.*

*"Tomatoes in the Farm Garden," Agr. Ext. Serv., Univ. of Tenn., Knoxville, Tenn., Leaflet No. 22 (Pub. 180 Rev.), June 1942, W. C. Pelton.*

*"Farmers Wise and Otherwise," Agr. Ext. Serv., Univ. of Tenn., Knoxville, Tenn., Leaflet No. 30, June 1942.*

*"Growing Vegetable Transplants," Ext. Serv., Univ. of Vt., Burlington, Vt., Brieflet No. 659, Feb. 1943, Charles H. Blasberg.*

*"Potatoes—Growing Them in Vermont," Agr. Ext. Serv., Univ. of Vt., Burlington, Vt., Brieflet No. 665, March 1943.*

*"Truck Crop Investigations," Agr. Exp. Sta., Norfolk, Va., Bul. 109, Oct. 1942, Harold T. Cook and L. L. Harter.*

*"Yellow Special Tobacco, A New Flue-Cured Variety Resistant to Black Root-Rot," Agr. Exp. Sta., Va. Polytechnic Inst., Blacksburg, Va., Bul. 346, Jan. 1943, E. M. Matthews and R. G. Henderson.*

*"Contribute to the Victory Program by Growing Winter Cover Crops," Agron. Dept., Va. Agr. Ext. Serv., Blacksburg, Va., E-362, July 1942.*

*"Victory Garden Program," Ext. Serv., Va. A. & M. College and Polytechnic Inst., Blacksburg, Va., E-371 (100M), March 1943.*

*"Report of Agricultural Research and Other Activities of the Western Washington Experiment Station," Exp. Sta., State College of Wash., Puyallup, Wash., March 31, 1942.*

*"Vegetable Varieties for Home and Commercial Gardens in Eastern, Central, and Western Washington," Agr. Exp. Sta., State Col. of Wash., Pullman, Wash., Pop. Bul. 167, Feb. 1943, C. L. Vincent, W. J. Clore, C. D. Schwartze, and T. E. Randall.*

*"Small Fruit Varieties for Home and Commercial Gardens in Eastern, Central, and Western Washington," Agr. Exp. Sta., State Col. of Wash., Pullman, Wash., Pop. Bul. 168, Feb. 1943, C. L. Vincent, W. J. Clore, and C. D. Schwartze.*

*"Commercial Spinach Culture in Western Washington," Western Wash. Exp. Sta., State College of Wash., Puyallup, Wash., Mimeo. Cir. 113, Feb. 1943, T. E. Randall and C. D. Schwartze.*

*"Lettuce Growing in Western Washington," Western Wash. Exp. Sta., State College of Wash., Puyallup, Wash., Mimeo. Cir. 114, Feb. 1943, C. D. Schwartze and T. E. Randall.*

*"Growing Pole Peas for Market in Western Washington," Western Wash. Exp. Sta., Puyallup, Wash., Mimeo. Cir. 115, Feb. 1943, C. D. Schwartze and T. E. Randall.*

*"Cabbage Growing in Western Washington," Western Wash. Exp. Sta., Puyallup, Wash., Mimeo. Cir. 116, Feb. 1943, C. D. Schwartze and T. E. Randall.*

*"Commercial Potato Production in Western Washington," Western Wash. Exp. Sta., State Col. of Wash., Puyallup, Wash., Mimeo. Cir. 117, March 1943, T. E. Randall.*

*"Growing Tomatoes in the Puget Sound Region," Western Wash. Exp. Sta., State Col. of Wash., Puyallup, Wash., Mimeo. Cir. 118,*

*March 1943, C. D. Schwartze and T. E. Randall.*

*"Growing Sweet Corn in Western Washington," Western Wash. Exp. Sta., State Col. of Wash., Puyallup, Wash., Mimeo. Cir. 119, March 1943, T. E. Randall and C. D. Schwartze.*

*"Regrassing for Soil Protection in the Southwest," U. S. D. A., Washington, D. C., F. B. 1913, Sept. 1942, Evan L. Flory and Charles G. Marshall.*

*"Hemp," U. S. D. A., Washington, D. C., F. B. 1935, Jan. 1943, B. B. Robinson.*

*"Victory Garden," U. S. D. A., Washington, D. C., AWI-30, 1943.*

*"Annual Report on Tobacco Statistics 1942," U. S. D. A., Washington, D. C.*

*"Applying the Techniques of Research to Extension Administration," U. S. D. A., Washington, D. C., E. Serv. Cir. 396, Nov. 1942, Barnard Joy.*

## Economics

¶ Surveys of farmer practices in growing tomatoes and lima beans in Delaware are given in two recent publications by the Extension Service in that State. Delaware Extension Mimeo. Circular 20, "Tomato Cost and Management Study, Delaware-1942," by E. P. Brasher, presents material similar to that given in surveys conducted in two previous years on this crop. Forty-five tomato growers with yields varying from 75 to 785 baskets per acre are included in the survey. Highest yield was not correlated with highest profit per acre, although in general high yields gave high profits; and as would be expected, low yields were associated with low profits and even losses per acre. High profits per acre were usually associated with higher costs per acre, although there were numerous discrepancies in this relationship. The heavier soils usually produced higher yields; and a comparison of fertility levels, as measured by soil tests, with yields indicated that the soils with higher organic matter, higher nitrate nitrogen, higher phosphorus, and higher potash content produced higher yields. Acidity and magnesium content seemed to have little influence on yields within the ranges found in this survey. Likewise, liming did not seem to have any particular influence on yield. Applying 150 to 250 lbs. of muriate of potash as a side-dresser just before the last cultivation increased yield markedly. Most growers use either stable or poultry manure in addition to fertilizer, the popular grades being the 2-8-10, 3-8-10, 4-8-8, 5-8-12, and 3-8-15.

¶ The lima bean survey, Delaware Extension Mimeo. Circular 19 "Lima Bean Cost and Management Study, Delaware-1942," also is presented by E. P. Brasher. This is the first survey on this crop conducted in Delaware, and 31 growers supplied the data. The yields varied from 2,171 lbs. down to 472 lbs per acre. Larger yields usually were associated with larger profits and low yields with losses. The largest individual yield was associated with the largest profit and the largest cost per acre of growing the crop, and this general relationship appeared to hold throughout the survey with some exception. The Henderson variety usually gave a higher profit than did Thorogreen. Applying the fertilizer in bands gave the highest yield, while broadcasting was intermediate, and fertilizer plowed down gave the lowest yield. The fertilizer analyses used included 3-8-10, 4-8-10, 4-8-8, 5-10-6, 5-8-12, and 5-10-5. The rate of application was around 500 to 600 lbs. per acre, with some going up to 800 and some as low as 300. Most growers used poultry or stable manure in addition to fertilizer. The author calls attention to the fact that both of these surveys represent the results of only one year's growing conditions, and therefore should not be interpreted too broadly. It is the intention to summarize the results of the three tomato surveys in a publication which will have much more significance.

*"Lima Bean Cost and Management Study," Agr. Ext. Serv., Univ. of Del., Newark, Del., Mimeo. Cir. 19, March 1943, E. P. Brasher.*

*"Tomato Cost and Management Study," Agr. Ext. Serv., Univ. of Del., Newark, Del., Mimeo. Cir. 20, April 1943, E. P. Brasher.*

*"Factors Affecting Farming Returns in Jackson County, Florida," Agr. Exp. Sta., Univ. of Fla., Gainesville, Fla., Bul. 377, Oct. 1942, Max E. Brunk.*

*"Peanuts for Oil," Agr. Exp. Sta., State College, Miss., Bul. 376, March 1943, Paul S. McComas, J. F. O'Kelly, and Frank J. Welch.*

*"Land Subdivision in the New Jersey Pines," Agr. Exp. Sta., Rutgers Univ., New Brunswick, N. J., Bul. 701, Nov. 1942, Joseph F. Hauck and Alvin T. M. Lee.*

*"A Study of Some Phases of Apple Production in Southern New Jersey," Agr. Exp. Sta., Rutgers Univ., New Brunswick, N. J., Bul. 703, Dec. 1942.*

*"Farming Efficiently Under War Conditions," Agr. Exp. Sta., Clemson Agr. College, Clemson, D. C., Cir. 63, Dec. 1942, M. J. Peterson.*

*"State and Local Financial Relations in Texas," Agr. Exp. Sta., A. & M. College, College Station, Texas, Bul. 618, Sept. 1942, H. C. Bradshaw.*

*"Virginia's 1943 Production Goals and Suggestions for Meeting Them," Agr. Ext. Serv., Blacksburg, Va., Bul. 154, Dec. 1942.*

*"Farming Systems in King and Snohomish Counties Washington, 1939," Agr. Exp. Sta., State Collee of Wash., Pullman, Wash., Bul. 424, Oct. 1942, Woodrow W. Rufener, Orlo H. Maughan, Ben H. Pubols, Earl W. Carlsen, and L. C. Wheeting.*

*"Back to the Country—The Rurban Trend in Washington's Population," Agr. Exp. Sta., State Col. of Wash., Pullman, Wash., Bul. 426, Dec. 1942, Carl F. Reuss.*

*"The Loss of Rural Manpower to War Industry Through Migration," Agr. Exp. Sta., State Col. of Wash., Pullman, Wash., Bul. 427, Jan. 1943, Paul H. Landis.*

*"A Graphic Summary of Farm Crops," U. S. D. A., Washington, D. C., Mis. Pub. 512, Feb. 1943.*

*"Cotton Quality Statistics United States 1941-42," U. S. D. A., Washington, D. C., December 1942.*

*"Progress of the Neighborhood Leader Plan," U. S. D. A., Washington, D. C., E. Ser. Cir. 393, Nov. 1942, Meredith C. Wilson.*

*"Feed a Fighter in 1943," U. S. D. A., Washington, D. C., E. Ser. Cir. 401, Jan. 1943, Z. L. Galloway.*

*"Suggestions for Building and Maintaining Interest and Enthusiasm of Neighborhood Leaders," U. S. D. A., Washington, D. C., E. Ser. Cir. 400, Jan. 1943, Lucinda Crile.*

# North American Deliveries of Potash Salts First Quarter of the Calendar Year 1943

DELIVERIES of potash salts within the continental United States, Canada, Cuba, Puerto Rico, and Hawaii by the four major producing companies during the first quarter of the calendar year 1943 amounted to 346,254 short tons of salts, equivalent to 178,883 tons of actual $K_2O$, according to the American Potash Institute. In this total there were, for agricultural use, 317,033 tons of salts, equivalent to 160,830 tons $K_2O$, made up of 228,051 tons of muriate, 61,137 tons of manure salts, and 27,845 tons of sulphates. For chemical use, deliveries amounted to 29,221 tons of salts, equivalent to 18,053 tons of $K_2O$. These figures include salts of domestic origin only.

Compared with the first quarter of 1942, these deliveries represent an increase of 26,581 tons of potash salts, equivalent to 14,000 tons $K_2O$, over the total of 319,673 tons of salts, equivalent to 164,877 tons $K_2O$, delivered during the corresponding period of a year ago. This represents an increase of 8%, principally in the category of agricultural salts.

For the twelve-month period, April 1, 1942 to March 31, 1943, total deliveries of potash salts by these companies amounted to 1,279,709 tons, equivalent to 674,161 tons $K_2O$. This is a 19% increase in salts and a 20% increase in $K_2O$-equivalent over deliveries of the preceding twelve-month period.

POTASH DELIVERIES

Short Tons $K_2O$

(United States, Canada, Cuba, Puerto Rico, Hawaii)

| | Jan.-March 1943 | Jan.-March 1942 |
|---|---|---|
| Muriate | 134,251 | 120,288 |
| Manure Salts | 15,284 | 14,519 |
| Sulphate and Sul. Pot. Mag. | 11,295 | 13,690 |
| Total Agricultural | 160,830 | 148,497 |
| Chemical Potash | 18,053 | 16,380 |
| Grand Total | 178,883 | 164,877 |

# Commercial Fertilizers

## (*A Book Review*)

WITH the appearance of the third edition of Gilbeart H. Collings' book, Commercial Fertilizers, this popular and useful work is brought up to date. (Commercial Fertilizers, Their Sources and Use by Gilbeart H. Collings, The Blakiston Company, Philadelphia, Third Edition, 1941. $4.50.) This book has gone through three editions within seven years, proof of its appeal and indication of the highly commendable desire of the author and publishers to keep the subject matter abreast of new developments.

This new edition is somewhat larger in format and contains 24 more pages than the second edition. While the general style and approach to the subject are the same as in former editions, the material has been rearranged to some extent, new developments have been introduced, and greater or decreased emphasis has been placed on certain subjects appropriate to trends in fertilizer manufacture and use.

A new chapter on the use of ammonia solutions as sources of nitrogen in fertilizers has been added. The greatly increased importance of the ammonia solutions within the last several years and the indications of their continued importance in the future of the fertilizer industry fully warrant the attention given them. The use of these solutions has been one of the most significant developments in the fertilizer industry.

The material on the potash industry also has been considerably revised with much more attention given to the greatly expanded American potash industry. The newer developments in the production of concentrated phosphates are covered in the appropriate chapters. A new chapter devoted to the so-called rarer elements has been included with considerable expansion of the material on the use of boron and some added information on manganese, copper, and zinc in line with increased information concerning the use of these materials in fertilizers. In the chapter on secondary elements, 12-color plates are included, which show nutrient-deficiency symptoms, particularly of the secondary and rarer elements.

New and appropriate sections on plant vitamins and hormones, fertilization of fish ponds, and rapid methods for determining fertilizer needs of soils and plants are introduced in this new edition. Statistical tables have been revised to include latest data available to the author when preparing the book, and new references have been added throughout the book.

Dr. Collings adheres rather closely to the manufacture and actual use of fertilizers, with only secondary attention given to the more theoretical aspects of plant nutrition, soil fertility systems, and soil chemistry. He covers the field indicated by the title and subtitle of his book in very complete manner, without giving undue attention to details of interest only to the specialist. For the latter, a very complete bibliography is given at the end of the book.

For those not familiar with former editions, a summary of the chapters will give an idea of the contents.

The book begins with a chapter covering the historical background on the use of fertilizers, with tables giving fertilizer consumption by countries, states, crops, and materials. The next three chapters are devoted to the mineral nitrogenous fertilizers, with the fifth chapter covering the organic nitrogen carriers. The following three chapters take up the phosphatic fertilizers. Chapter nine deals with the use of ammonia solutions in fertilizers, and chapter ten covers the production and use of potash fertilizers. The following two chapters consider, respectively, the secondary and the rarer nutrient ele-

ments. Chapter thirteen takes up the elements frequently found in plants but not considered essential to plant growth. The next chapter deals with soil acidity and its influence on fertilizer response. The fifteenth chapter gives practical information on wise purchasing of fertilizers while the following chapter gives general and at the same time practical suggestions on the use of fertilizers relative to crop, soil conditions, selection of carrier, and related factors. These two chapters might be considered an applied summary of much that was previously covered in the book. The final chapter is devoted principally to fertilizer placement.

The publishers are to be complimented on the excellent typography, good printing, and the very durable and serviceable binding of the book.—J. D. Romaine.

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# Malnutrition Symptoms and Plant Tissue Tests of Vegetable Crops

(*From page* 10)

toms appeared with levels in the tissue of 2,600, 3,200, and up to 4,500 p.p.m. It is probable that the level in the tissue should be from 5,000 to 7,000 p.p.m. and that a level of 3,000 or lower will be associated with symptoms of deficiency. The total omission of potassium from the nutrient solution resulted in a marked increase of phosphorus, magnesium, and nitrogen in the plant tissue.

Slight symptoms of deficiency consisted of a dwarf habit of growth, dark green foliage, and as the plant matured, slight yellowing and white scorching of the margins of basal leaves. More severe deficiency caused the plants to be decidedly dwarfed, leaves reduced in size with the tips and margins yellowing, then the affected tissue dying and becoming thin and papery in texture, white in color, (fig. 5).

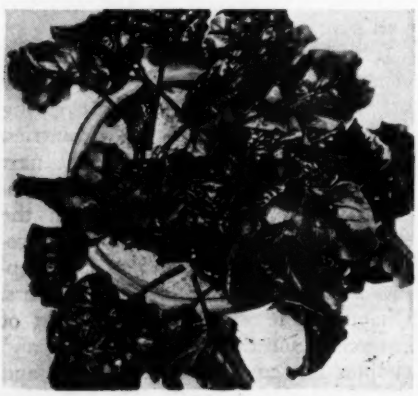

**Fig. 7. Incipient stage of boron deficiency. Pigmentation intensified and leaves very high in lustre.**

No definite symptoms of magnesium deficiency were noted, although the reduction of this element in the nutrient solution resulted in a marked decrease of magnesium in the plant tissue.

A group of plants was also grown with a nutrient solution lacking boron. The foliage symptoms started as a disappearance of chlorophyll from all the venation, followed by a disappearance from the intervenal areas, leaving the affected leaves white in color. The growing points died. The most marked effect was the failure of any of the blossoms to set.

**Beets**—Owing to the difficulty of securing clear extracts, no plant tissue tests were made with beets.

Although a deficiency of nitrogen caused the purple pigmentation to be intensified in the younger leaves, the older leaves faded to a light yellowish-green. The plants were somewhat dwarfed, lacking vigor, with slender leaf stalks.

The leaves of phosphorus-deficient plants were much reduced in size and had short petioles. The foliage was a dull purple color with the underside of

the leaf entirely overcast with purple pigmentation, (fig. 6).

Distinctive symptoms were observed in plants not receiving boron, commencing as a marked intensification of purple pigmentation and distortion of the leaves. The purple pigmentation was much more intense than in the case of phosphorus deficiency, hiding the natural green of the leaf completely. The leaves had a high luster in contrast to the dull appearance of phosphorus-deficient foliage, and the leaves were ruffled and cupped in contrast to the smooth, flat leaves of phosphorus deficiency, (fig. 7).

Later the young, developing leaves became a dull orange with the leaf petioles the same color. Death of the growing point occurred, leaving the plants with typical open centers or crowns. Large black cankers were found on the surface of the beets, usually at the point of the greatest circumference.

Potassium deficiency was characterized by dull, muddy foliage which later exhibited a whitish-gray mottling, frequently toward the outer edge of the leaf but not following a distinct pattern, sometimes occurring in fairly large isolated patches. Later these areas died and became brown in color, (fig. 8).

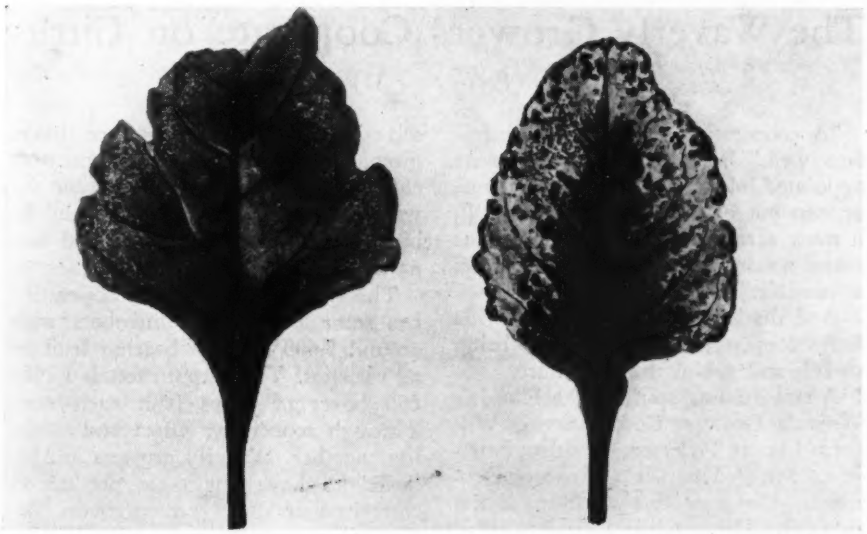

**Fig. 8. Deficient potassium. Outer edge of leaf exhibited whitish-gray mottling and later died.**

# Poultry Manure—Source of Nitrogen

(*From page* 18)

It has also been observed both here and in England that there seems to be a plant hormone action from manure which is beneficial to crops.

At Massachusetts State College, specialists in the various fields make the following brief recommendations for use of poultry manure, or manure and the inorganic combination of fertilizers.

**Lawns and Golf Courses.** Poultry manure is one of the best fertilizers that can be obtained from the standpoint of grass growth. It should be applied in the late fall or winter. The objectionable features are weed seed, objectionable odor, undesirable litter,

and some burning from which the plants quickly recover.

**Pastures and Crops.** Poultry manure is entirely satisfactory as a source of fertility, but should be supplemented for many of the crops, particularly clover. It contains a variety of less common minerals which may be very valuable.

**Fruits and Berries.** It is very useful when used in moderation, and should be applied in the spring or very late fall. If the poultry ration contains magnesium, it will be especially valuable for fruit. It is excellent for strawberries when applied the year before the crop is set. For raspberries, it should be applied in the early spring.

**Vegetables.** For fertilizing vegetables it is absolutely satisfactory. Litter manure can be applied up to 16 to 20 tons to the acre, and straight droppings up to 5 or 6 tons. It should be used more sparingly with peppers, tomatoes, and potatoes.

**Flowers.** When spaded under in the spring, poultry manure can be used at a reasonably heavy rate for both annuals and perennials.

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# The Waverly Growers Cooperate on Citrus

(*From page* 22)

"A cooperative must serve its members well," he said. "It must do its appointed job better than independents, or step out of the picture. Above all, it must earn its way by performing as many needed services for its members as possible."

And that's exactly what this Florida citrus cooperative is doing. It is being useful, and useful things endure.

A real guiding spirit in the Florida's Waverly Growers Cooperative is Wilhelm Lorenz Pedersen, president emeritus. Mr. Pedersen is a native of Denmark. He came to the United States in 1884. For a while he ran a small jewelry store in Iowa and later operated a larger jewelry store in another part of the state.

In addition to his jewelry business in Clarinda, Iowa, he became engaged in agriculture—a very vital industry in Denmark. Later he sold out his jewelry business in Iowa and gave up his agricultural interest, too. Then he came to Florida and became a pioneer in citrus growing in the Waverly area.

He is getting up in years now, but he still thinks that through cooperative effort, the Florida citrus industry will really go places.

"I love to help others help themselves," he says. "I love to see things grow, like citrus trees and cooperative enterprises. By working together we will go forward to great heights and do big things for our growers and our nation."

The Waverly Growers Cooperative has some 200 grower members with around 5,600 acres of bearing fruit of all varieties. The output exceeds 1,250,000 boxes of citrus fruit each year. Through cooperative effort and working together, Waverly growers are believed to have cut their production costs in half during recent years, despite the higher wages being paid to labor.

At Waverly there is a spirit of friendliness and wholesome good fellowship. The management takes great pleasure in showing guests around the plant. Every year the number of visitors increases. The reception is not a matter of "Glad to see you, come back to see us another time." It is a cordial greeting and an eagerness to show visitors all over the immense cooperative plant.

There is a personal escort who courteously explains in detail every operation of the plant.

While the inspection is being made, the employees go about their tasks uninterrupted. Every worker is in spic-and-span uniform. The plant is as clean as a pin. There is nothing artificial about it. The naturalness of the cooperative's systematic operations is just as impressive as the common-sense practices they are using in servicing the groves of their members.

The employees at Waverly know they are being treated about as well as human beings can be treated. They have many advantages which they seem to appreciate:

Comfortable rest and recreation rooms are provided for both men and women. These are equipped with modern lounges and easy chairs, table tennis, chess, and other indoor entertainments. There are also modern work rooms and dressing rooms. Excellent meals are served employees at actual cost, in a cafeteria and lunch room.

At Waverly the employees of a unique and moving cooperative are satisfied. And that is another reason why this band of growers has been so successful. They believe in the motto, "Live and help live." They are happy in this practical application of a democratic principle, because those who work for them are contented in it, too!

Here truly is a cooperative that has put cooperation into actual practice. If you don't believe it, drop in some day and ask them all about it. They won't just talk and tell you what they are doing. They will show you and make you believe.

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# Can Legumes Be Over-Emphasized?

(*From page* 26)

ing organic matter than on the fallow soil, as an increase from 16 to 30 p.p.m. was obtained through these organic matter treatments. Likewise, the replaceable potassium content of the legume-treated soils increased from 48 to 145 p.p.m. This suggests that the organic matter content of soil of the Southeast can be increased by either using summer or winter legumes as green manure crops and that such additions not only add considerable nitrate-nitrogen, but also render phosphorus and potash more available for crop production.

**Fig. 3. Vetch in a cotton-corn rotation is beneficial in soil conservation. The annual runoff from this rotation was 17%, while an erosion loss of 24 tons per acre occurred; whereas the cotton-corn system lost 24% of the total rainfall as runoff and gave a soil loss of 59 tons per acre.**

# Value and Limitations of Methods of Diagnosing Plant Nutrient Needs

(*From page* 15)

ing but none later in the day when nitrogen metabolism has caused the plant to use the nitrates as fast as they enter. Such a plant needs more nitrogen.

These variations indicate that one needs to use some consideration of the changing situations involved when making the interpretations of the tests.

Investigators in soil-fertility research have not made as fast progress as possible because the point of view has not sufficiently included the "why of things" or the "how" and "why" of all the factors functioning in the performances of a growing crop. When the influences of all the potentialities within the sciences are to be considered in solving these crop problems, the investigator finds it necessary to do some systematic thinking and to follow a diagnostic procedure. This means that all known factors are examined and weighed before arriving at conclusions. Thus in studying the nutritional status of crops whether in experiments, fields, greenhouses, gardens, or in flower pots, one is constantly confronted with the problem of examining and arraying all possible facts before any conclusions can be drawn. Since the supplies of nitrates, inorganic phosphates, and potash are the most frequently encountered critical factors, the diagnostician has gained much when the guessing about their adequacy is eliminated.

***Plant Tissue Tests Prove Valuable in Fertility Research.*** Progress in fertility research is seriously handicapped as long as investigators are satisfied to ignore or guess at the nutritional status within the growing crop. It is a fallacy to argue that a technique exists that answers all the nutritional questions; yet when the tissue test method can indicate a "low" or "high" supply, or a state of balance of nitrate, or phosphate, or potash at an

TABLE I.—PLANT TISSUE TESTS AS AN AID IN THE STUDY OF LONG-TIME FERTILITY EXPERIMENTS WHERE VARIOUS PHOSPHATE CARRIERS ARE COMPARED. TESTS MADE ON CORN AT EARLY TASSELING STAGE. (HUNTINGTON, INDIANA; JULY 18, 1941. DATA BY M. T. VITTUM.)

| Plot | Treatment* | Plant tissue tests | | | Average yield (Bu. per acre) 1919–1940 | 1941 Yield |
|---|---|---|---|---|---|---|
| | | Nitrogen | Phosphorus | Potash | | |
| 1 | None | High | Very Low | Very Low | 36.1 | 26.8 |
| 3 | BS | High | Low | Very Low | 38.4 | 45.1 |
| 4 | SP | High | Low | Very Low | 37.6 | 49.3 |
| 5 | RP | High | Low | Very Low | 34.2 | 43.7 |
| 7 | L+BS | High | Very Low | Very Low | 39.1 | 45.1 |
| 8 | L+SP | High | Very High | Very Low | 39.3 | 36.6 |
| 9 | L+RP | High | High | Very Low | 37.5 | 35.2 |
| 20 | | High | Low | Very Low | 44.8 | 54.9 |
| 21 | | High | Medium | Low | 45.7 | 56.3 |

* BS=200# of 18% basic slag per acre on corn and wheat.
SP=180# of 20% superphosphate per acre on corn and wheat.
RP=480# of 30% rock phosphate per acre on corn and wheat.
L=2 tons of ground limestone per acre applied in 1919.
Res.=Cornstalks and straw returned to the land.
PK=300# of 0-12-4 per acre on corn and wheat.

TABLE II.—CORRELATION OF PLANT TISSUE TESTS WITH RATES OF NITROGEN AND POTASSIUM FERTILIZATION. TREATMENTS AND YIELDS OF CORN. (DATA BY H. L. COOK, ON CROSBY SILT LOAM, LAFAYETTE, INDIANA, 1940.)

| No. | | Materials plowed under *in lbs. per acre* [1] | | Yield Bu/A. | Increases above treatment No. 1[3] | Plant tissue test[4] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *July 10* | | | *Aug. 1* | | |
| | | N[2] | $K_2O$ | | | N | P | K | N | P | K |
| I | 1 | 0 | 0 | 29.5 | | O | H | H | O | H | M |
| | 2 | 21 | 0 | 36.3 | 6.8 | M | H | M | O | H | L |
| | 3 | 42 | 0 | 49.4 | 19.9 | H | H | L | M | H | O |
| | 4 | 84 | 0 | 52.8 | 23.3 | H | H | O | H | H | O |
| II | 11 | 0 | 50 | 30.8 | 1.3 | O | H | H | O | H | H |
| | 5 | 21 | 50 | 49.4 | 19.9 | L | H | H | O | H | H |
| | 7 | 42 | 50 | 56.2 | 26.1 | H | H | H | O | H | M |
| | 9 | 84 | 50 | 68.1 | 38.6 | H | H | H | H | H | M |
| III | 12 | 0 | 100 | 33.8 | 4.3 | O | H | H | O | H | H |
| | 6 | 21 | 100 | 50.1 | 20.6 | L | H | H | O | H | H |
| | 8 | 42 | 100 | 59.3 | 29.8 | H | H | H | O | H | H |
| | 10 | 84 | 100 | 71.8 | 42.3 | H | H | H | M | H | H |

[1] All plots received 300 lbs./acre of 0-16-4 at planting time.
[2] N was in form of cyanamid. Similar data are available with N in the form of ammonium sulfate.
[3] Significant difference 3.2 bus./acre.
[4] O, none; L, low; M, medium; H, high. Tests are an average of 6 plants from each of 5 replicates.

early stage of the plant growth, or throughout its growing period, it seems like common sense to consider such information valuable.

A typical "case history" is given in Table I to show how the tissue tests aid in studying old fertility experiments.

One of the permanent, general-fertility experiments maintained by the Purdue Experiment Station has been running continuously since 1919. This field at Huntington, Indiana, includes a comparison of various sources of phosphates for crop production. Inasmuch as these phosphate plots were laid out at a time when it was believed that the soil could supply adequate quantities of potassium for normal plant growth, potash was not included in the treatments.

The results of these tissue tests show that on the plots where various carriers of phosphates have been compared, potash has been the first limiting factor in the growth of corn. The yields of these plots have, therefore, been a function of the available potash instead of phosphorus, and the results obtained from the different phosphates are misleading. Plot 21, which had received some potash, was not receiving enough to supply the plants adequately.

As a result of these tissue tests, the potash deficiency has been corrected by adequate additions of KCl, so that in the future the yields will be a function of the phosphates used and a true comparison of the different forms of phosphates will be obtained.

In recent investigations at Purdue, much progress has been made in finding effective means of fertilizing corn directly on impoverished soils. A typical case history that illustrates this is presented in Table II.

Attention is called to the following:

1. Phosphate was adequate in all plots; without the tissue tests, one would not be sure of this point.

2. In Group I, the tissue tests show that nitrogen was the first limiting element; but as the rate of application of nitrogen is increased, potassium becomes limiting. Without the tissue

test, we might assume that the larger nitrogen treatments were not very effective.

3. In Group II, where 100 pounds of muriate of potash was plowed under with the nitrogen, it is apparent that nitrogen has become the limiting element except on the higher rates where the plowing down of a phosphate fertilizer was compared with a similar application of phosphate in the row at planting time. In both cases the nitrogen and potash were plowed under. The season was characterized by a prolonged drought during July and August. Although the corn on the plowed-

TABLE III.—PLANT TISSUE TESTS AS AN AID IN STUDYING PHOSPHATE FERTILIZER PLACEMENT FOR CORN. (DATA BY A. J. OHLROGGE, ON CROSBY SILT LOAM, LAFAYETTE, INDIANA, 1940.)

| Fertilizer Treatment, lbs. per acre | | Plant Tissue Test | | | Yield Bus./A |
|---|---|---|---|---|---|
| Plowed under | Drilled in row | N | P | K | |
| 120 lbs. N<br>120 lbs. $K_2O$ | 120 lbs. $P_2O_5$ | VH | L | H | 56.6 |
| 120 lbs. N<br>120 lbs. $P_2O_5$<br>120 lbs. $K_2O$ | | H | H | H | 67.3 |

the adequacy of potash had become doubtful by August 1.

4. In Group III, where 200 pounds of muriate were used, the potash test shows an adequate supply and the yields then become a function of the nitrogen application. Here it is interesting to note that nitrogen had become limiting by August 1, and that higher rates of application probably would have produced additional corn.

The point of view in the research represented by Table II was to find first, if possible, the boundaries of the nutritional factors necessary to produce an acceptable corn yield. In this approach, the costs of the treatments were not the deciding factors. The needs of the growing plant were the prime factors considered. To this end the plant tissue technique was used. Each season some limitations in the experiments were exposed by these tissue tests. This permitted corrections to be made for the next experiments. It was found that many assumptions, even old standard practices, were not measuring up to the requirements of the plants.

For example, during the 1940 season under fertilizer plot started slowly, it appeared more vigorous throughout the latter part of the growing season. Plant tissue tests were made on the corn plants the first week of August.

It was found on exposing a profile across the corn rows that very few active roots were in the very dry soil in which the row fertilizer was placed. On the other hand, there was an abundant growth of live roots in the moist soil at plow depth in which the plowed-under phosphate was placed. In this instance, the plant tissue test aided in diagnosing the role of fertilizer placement in plant nutrition. While the final yield showed that the phosphate placed in the row was not as effective as that plowed under, one would be inclined to assume that 120 lbs. of $P_2O_5$ per acre applied in the row would be more than enough phosphate for the corn. However, the tissue tests showed that the plants were not getting it from the dry soil.

More rapid progress was made in the experiments by defining the nutritional boundaries involved, and much time in the annual replication of these experiments has been eliminated. With

the optimum rate of nutrient supply and the method of placement accurately bounded, the next phase of the research was possible, i. e., to find the most economical way to meet these requirements for the crops grown under specific soil conditions. This is being done in experiments that have been conducted the past four years in which heavy applications of fertilizers have been used to obtain the lowest cost units of production.

# Victory Vitamins

(*From page* 5)

physical culture, and protect the purse from points and pennies. Instead of perfecting a good golf stance, I prefer to do my own sod chopping where it will be of some normal use. My leathery coat of tan and my wife's fresco of freckles have been acquired on our own fairway of bucolic content.

To many, gardening is something brand new; to others, it is an old story. Archaeologists who dig into the bowels of the earth on the sites of ancient cities discover traces of garden ornaments. The Indian historians show us plenty of evidence that the red brother cultivated the corn plant long before we cultivated him with corn whiskey. Colonial patriots at times were prouder of having grown a prize pumpkin than to have their spluttering signatures on the Declaration of Independence. Sage, pennyroyal, rosemary and mint, and the bright garlands of roses and English ivy were the compensations which our New England mothers enjoyed in return for severing home ties to begin life anew in this savage-haunted realm.

They feed tomato juice and spinach to infants, dill pickles to debutantes, and extracts of sauerkraut to vitalize our declining years. They bring flowers to mothers of new-born babes, and the florist enjoys his reward along with the undertaker. No human habitation assumes its right proportions or hides its visible defects without herbage and flora. Science has stepped in and provided the setting for almost unlimited expansion for horticulture.

Yet I have observed that horticulturists are among the most timid and reticent of mortals, despite this vantage point of universal esteem. Beginners seeking to grow their own vine and fig tree on heaps of earth thrown out of the cellar hole turn to the expert for advice and succor.

They come to the horticulturist wanting to grow the earliest tomatoes and the climbingest roses, the most headstrong cabbage and the strongest tear-jerking onions that nature and their own skill can produce. They are anxious to have worms for bait, but frown on grub worms in their sod. They write to the horticulturist to learn what to concoct that will deal sudden and permanent extinction for "those hump-backed bugs that raise warts on cucumbers."

The more adventurous of them seek a way to graft a tomato bud on a potato root stalk so as to get chili sauce above and French fries below. Although they are father confessors to many vegetable homicides, their chief fault is their modesty. Even though you point to nursery catalogs to confuse me here, I rejoin with the reminder that those pamphlets first pass through the hands of journalists to stock up on militant optimism. Your natural-born horticulturist will minimize rather than extol his own efforts.

In America, the livestock feeders and students of field crops have pushed the horticulturists off the map, with few exceptions. As a consequence, we have had more pork than apple sauce and more corned beef than cabbage. But despite these drawbacks due to mental reticence, I know these gentle horticulturists will never abandon orchard grafting for the other kind.

Whether or not the newly-converted followers of old Linnaeus ever succeed in producing all their horticultural ambitions during this hectic summer, I am sure they will profit by their sweat just the same.

Northern gardening on old soils amid the breeding places of all the noxious insects known to the state entomologist or the exterminator is surely a great thing to promote stamina as well as sunburn. Despite lice on my turnips and slugs on my tomatoes, despite long winters and short asparagus, I tell you I would not trade my honest hours with the hoe for all the largess of the tropics.

BEAUTY and satisfaction in gardens are just like that legendary blue bird of happiness. One need not chase far afield in a vain hunt for them. Your own will and favorable weather soon bring them to pass beside your modest door. If perchance you must rent some ground somewhat removed from your habitation, the joy of lugging home the stuff—if there is anything to lug—will be ample reward for the hours spent fighting mosquitoes with one hand and eradicating blister beetles with the other.

I find myself slyly attended by a quota of constant companions as I dig and delve. These chance acquaintances of mine who likewise love this form of outdoor sport are the robin, the chipmunk, the toad, the rabbit, and the garter snake. Sometimes I think I may be the real interloper, not they.

The rabbit seems to think so at least, for he lives up to the Uncle Wiggly stories I used to read to the kids by nibbling voraciously at my peas that do not pod, and my beans that do not wax. The toad and the snake are my allies, for they kill more insects than I do, and with less expensive equipment. The robin flits about watching me spade and hoe, and when my back is turned, he seizes upon wriggly morsels found in the furrows. The darting chipmunk is my daily reminder to step lively in good old American fashion, so as to keep ahead of Jack Frost and the tax collector.

The mystery of growth and fruitfulness, a changing aspect from morn to night, the secret chemistry of plant and soil, the tranquil moment in the amber twilight, the cleaning of the hoe at nightfall preparatory to a fond farewell as the curtain falls on another day; when Mother calls the children to bed, and I sit down to spoil it all by reading of fierce warfare abroad—that's my American home beside my ambitious garden.

But America has sprung from an original race of open country folks. Like foxes confined who dig furtively at foundation walls; so, too, the close-hemmed masses of our modern crushing city life desire to dig their knuckles into the pulsing earth and thus revive their latent instincts to produce.

It's a great game if you don't weaken. He who gets close to the soil may imbibe some of the alchemy of its age-old power and promise, even if what he can't is greater than what he cans therefrom.

But let me add just one last word of caution to the novice who stakes out his plot this spring. Either omit melons altogether as being too space-devouring, or keep a watchful eye upon them in case you can't resist their planting. Your neighbor boy is no better than you were at his age, remember—for he is half-brother to the rabbit anyway and likes to forage for stolen fruits.

WITH this final fling I leave you to hardscrabble along as best you may without further recourse to professional hints and paternal suggestions. Remember there is a real point to having a good garden this year—in fact several points—the kind that count so much in your ration books. And when you get everything garnered and much succulence canned, give me a ring and I'll drop in for dinner and sample the quality of your production. In this service, none can excel me for promptness and quick compliance.

## AVAILABLE LITERATURE

The following literature on the use of fertilizers in profitable soil and crop management is available for distribution. We shall be glad to send these upon request and in reasonable amounts as long as our supply lasts.

### Circulars

**Potash Pays on Grain** (South)
**Greater Profits from Cotton**
**Tomatoes** (General)
**Asparagus** (General)
**Vine Crops** (General)
**Sweet Potatoes** (General)
**Grow More Corn** (South)
**Fertilizing Small Fruits** (Pacific Coast)
**Potash Hungry Fruit Trees** (Pacific Coast)
**Fertilize Potatoes for Quality and Profits** (Pacific Coast)
**Better Corn** (Midwest) and (Northeast)
**The Cow and Her Pasture** (General)
**Fertilize Pastures for Better Livestock** (Pacific Coast)
**What You Sow This Fall** (Canada)
**Home-grown Grains for Profitable Hogs** (Canada)
**What About Clover?** (Canada)
**Of Course I'm Interested** (Pastures, Canada)
**Meet the Family** (Canada)

### Reprints

**T-8 A Balanced Fertilizer for Bright Tobacco**
**CC-8 How I Control Black-spot**
**II-8 Balanced Fertilizers Make Fine Oranges**
**N-9 Problems of Feeding Cigarleaf Tobacco**
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**THE AMERICAN POTASH INSTITUTE**
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Mother was telling stories of the time she was a little girl. Little Harold listened thoughtfully as she told of riding a pony, sliding down the haystack and wading in the brook on the farm.

Finally he said with a sigh, "I wish I had met you earlier, mother."

---

THE PROPRIETIES

Mike and Cassidy met in the lodge room.

"Sure, Mike, my bhoy, and what's the idea of wearing a mourning band on your left leg?" asked Cassidy wonderingly.

"Me mither has passed away, an' all an' all," said Mike miserably.

Cassidy scratched his head, puzzled.

"Why, then do you wear it on your leg instead of on your arm?" he asked.

"Well, she was my stepmither," said the other.

---

GOOD MUSIC

"Dad intimated that your playing was heavenly."

"He did."

"Yes; he said, 'Where do those unearthly sounds come from?'"

---

"Papa," asked Willie, "what is middle age?"

"It's the time of life, son," he replied, "when you would rather not have a good time than recover from it."

---

Gob: "Can you read my mind?"

Gal: "Yes."

Gob: "Go ahead."

Gal: "No, *you* go ahead!"

Two young ladies were walking down Fifth avenue. Suddenly one cut loose with a piercing shriek.

"Look," she cried in amazement.

"What's so terrible?" asked her friend. "That's only a midget."

"Thank God," said the other girl, greatly relieved. "I thought they were rationing men."

---

To be fit for life in society, every child, as well as every dog, must be housebroken.—*Dr. Edwin G. Conklin.*

---

SAVED

A man was stranded on a desert island; he was afraid of cannibals, so he moved very cautiously. As he was climbing up a small hill he heard voices:

"Who in the hell trumped my ace?"

The man lifted his eyes to heaven and said, "Thank God, there are Christians on this island."

---

"Did you notice Laura is getting a double chin?"

"Yes, I guess it was too much work for one."

---

A lady visitor at one of the busy Kaiser shipyards on the Pacific Coast recently stooped over to tie a knot in her shoe. The next thing she knew, a bottle of champagne was broken across her stern and she was launched!

---

It takes a long time to get acquainted but only a minute to fall in love, and the tragedy of many is that they fell in love before they got acquainted.

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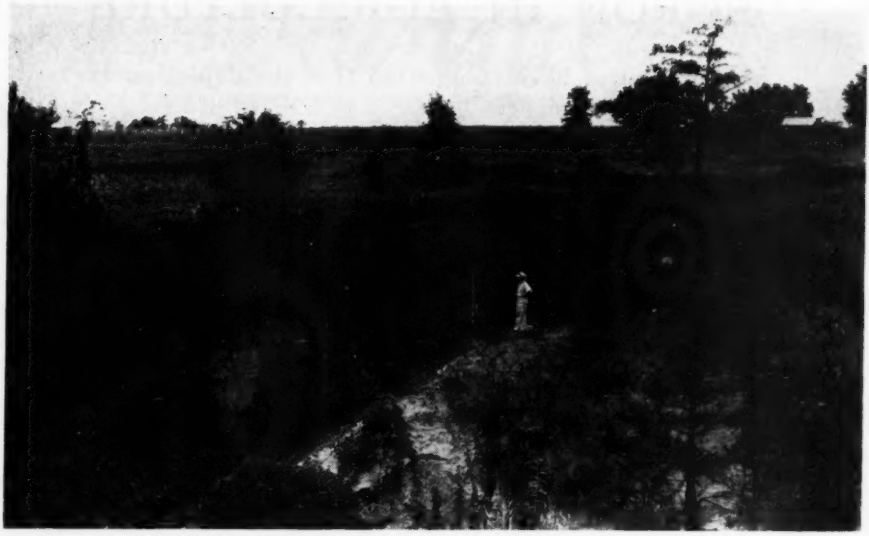

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*President American Potash Institute*

**AMERICAN CHEMICAL SOCIETY MONOGRAPH NO. 91**

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